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THE MANCHESTER CANAL report for the half year ending Dec. 31, 1895, shows that tolls were paid upon 758,000 tons as compared with 555,000 tons in the same period in 1894. For the year 1895 the tonnage was 1,358,000 tons against 925,000 tons in 1894. The earnings of the canal do not yet meet its charges and the City of Manchester receives no interest on its $25,000,000 borrowed at 3% and loaned to the canal at 4½%. The gross earnings of the canal for the half-year were $372,000, with net earnings of $75,500. There is an increase of $85,000 in the operating expenses owing to the fact that these must be now paid out of earnings instead of being charged to capital account, as in the past. Including revenue from the Bridgewater Canal the total net receipts for the half year were $200,500; but the fixed charge on debentures amount to $800,000 for the same period.

THE KIEL SHIP CANAL, according to a late definite official statement, cost the German government a total of $39,000,000. This includes a depth of 20 ft. at dead low water, and dredging is still in progress with the object of providing a channel available to the largest vessels at any stage of tide.

THE PANAMA AND NICARAGUA CANAL COMPANIES are to be consolidated, according to a rumor from Paris, which Mr. John R. Bartlett, President of the Nicaragua Canal Co., to some extent supports. Mr. Bartlett says that negotiations to this end have been in progress, embodying the purchase of the Panama Canal property and the advance of the Nicaragua project, under combined French, English and American control, with the management in American hands. But so far all overtures have been so informal and non-binding that no official action of any kind has been taken by the boards of the two companies.

OHIO SHIP CANALS have been reported upon to the Chief of Engineers, under the River and Harbor Act of 1894, directing the Secretary of War to have a survey made of three proposed canals, in Ohio, with a view of ascertaining the feasibility and advisability of connecting Lake Erie with the Ohio River. The report says that the cost of converting existing canals into ship-canals, 70 ft. wide and 7 ft. deep, with necessary locks, etc., for carrying vessels of 280 tons, is estimated as follows: Eastern route, Cleveland to Marietta, $12,299,372; Central route, Sandusky Bay to Portsmouh, $18,094,165; Western route, Toledo to Cincinnati, $25,011,374. No recommendation is made, and while either route is regarded as feasible the reporting board of engineers does not find the proposed improvements advisable.

THE CASCADE LOCKS, at the Dalles of the Columbia River Oregon, have been examined and reported upon by the Chamber of Commerce of Portland, with a view to hastening their completion. The report says that the stonework and masonry were to be completed by March 1 and the dams removed so as to allow boats to pass through the canal. But the locks can not be operated until concrete walls can be built to prevent the washing down of loose rock and dirt and to provide against the disintegration of rock originally assumed to be solid. Extensive rip-rapping is also needed. The board passed resolutions urging the immediate appropriation of $179,597 to make this work available for navigation.

A COLLISION OF CABLE CARS occurred March 2 on the Lexington Ave. line, in New York city. A car on the steep grade from 102d to 103d St. got beyond control and after knocking down a woman who was crossing the track it ran into the car ahead. The next car behind also got beyond control and ran into the other car. All the cars were empty.

A FOUR-SCREW HOPPER DREDGE of the ladder type has been in use at the port of Bristol, England, for about ten years, working in the Bristol, Avonmouth and Portishead docks and the river Avon. The hull is 218 ft. long, and the ladder well extends through the forward end, so that the buckets can cut in advance of the hull. There are three hoppers, with an aggregate capacity of 25,000 cu. ft., or about 1,000 tons, which amount can be dredged in one hour. The draft is 14 ft. 6 ins. loaded, and 10 ft. 6 ins. light, and the buckets can dredge to a depth of 36 ft. below the water line, with the ladder at an angle of 45°. There are two sets of triple-expansion engines of the marine type, developing 1,300 I. HP. at a piston speed of 500 ft. per minute, and with a boiler pressure of 140 lbs. per sq. in., steam being supplied by three marine boilers. The cylinders are 17, 27 and 43 ins. diameter and 30 ins. stroke. Either or both engines can be utilized for driving the dredging machinery or the propeller shafts, two of which pass through the hoppers in tunnels utilized to strengthen the hull. The propellers are 8 ft. 4 ins. diameter, each having three cast-steel blades bolted to a cast-steel boss. The vessel can be driven at nine knots per hour with full load in the hoppers, and the use of the double-end plan was adopted to give equal steaming and steering facility in either direction, as the river is not wide enough for the vessel to turn. The bucket ladder is a plate girder, 85 ft. c. to c., and carries the ladder chain with 36 steel buckets of 17½ cu. ft. capacity. The material can be discharged into the hoppers or into scows. It is said that 120 to 150 I. HP. is required in dredging, of which probably 70% is absorbed by the machinery. The machine works mainly in mud and sand, but has dredged 72,000 tons of concrete wall, sandstone rock (the buckets bringing up pieces weighing 1,680 to 3,300 lbs., and in one case a block of 2¾ tons in one bucket). Piles 20 ft. long have also been removed, the buckets cutting into the wood and lifting the piles out. Large blocks are removed from the buckets by a crane.

THE PROPOSED DOCK IMPROVEMENTS for New York city will involve an expenditure of over $9,000,000, according to the five bills forwarded to the State legislature by the Dock Commission. One of these bills asks for power to issue $6,000,000 in 30-year 5% bonds, for the acquisition of property along the river front; another raises the salary of Chief Engineer Greene from $6,000 to $12,000 per year, and the construction already planned will raise the total expenditure to the sum named. Under the present law, only $3,000,000 in dock bonds can be issued annually, and if the relief to shipping, so urgently demanded, is to be secured, the legislature must act. The proposed improvements would provide six new piers on the North River for large transatlantic steamers; five new piers, for domestic shipping, on the East River, and more room for certain coastwise transport lines. The estimated annual direct revenue of the city, from the proposed expenditure of $9,000,000, is $500,000, or over 5% interest.

A SECTIONAL DRY-DOCK at the Erie Basin, Brooklyn, is to be built by the International Dry Dock & Construction Co., of New York. The dock is to be built in seven sections, each 66½ ft. long over all, 116 ft. 10 ins. molded width, and 12 ft. 11 ins. deep at center. The estimated cost is $300,000, and the time of construction nine months. It is so designed that the dock can be extended at any time so as to dock the largest vessel afloat.

THE LENGTHENING OF AN OCEAN STEAMER is a rather unusual work now being carried out by Harland & Wolff at Belfast, Ireland. The steamer is the "Scot," of the South African Mail Line, which holds the speed record between England and Cape Colony. The boilers have been removed, and the rivets cut from the shell plating seams amidships. The bow will be moved forward by hydraulic jacks and steam hoisting engines for a distance of about 50 ft., which is the extent to which the hull is to be lengthened. The steamer is 502 ft. long over all, and 460 ft. on the water line, 54½ ft beam and 37½ ft. molded depth; it has a tonnage of 6,884 tons, and a displacement of 10,000 tons. It is propelled by two triple expansion engines and twin screws.

THE BATTLESHIP "INDIANA," going at a speed of 12 knots, can easily turn within a diameter equal to three times her length of 348 ft.; this is equivalent to a tactical diameter of 1,044 ft. In the report of the board of experts in which the above statement occurs, it is also pointed out that the eight 8-in. guns on the "Indiana," in four separate turrets, cannot be fired on a direct line with the keel, owing to the blast from these guns being dangerous to the operators in the larger 13-in. gun turrets located below and between the 8-in guns. It will be necessary to put stops on the smaller turrets so that they cannot be fired nearer than 10° to the direct line of fire. The result has been anticipated by the ordnance officers.

THE TORPEDO-BOAT "ERICSSON" will now be accepted by the government as a result of her recent dock trial. But while the boat is strong and durable and built according to specifications, the machinery weighs nearly six tons more than it should. The builders, the Iowa Iron Works, of Dubuque, waive the right to any further attempts to earn a premium for excess of contract speed, and they forfeit $16,000 for overtime penalties.

THE HOLLAND SUBMARINE BOAT, now being built under contract with the U. S. Navy Department, at the Columbian Iron Works, in Baltimore, is thus described by the "News" of that city: Length, 80 ft.; maximum diameter, 11 ft.; displacement at surface, 118.5 tons, and totally submerged, 138.5 tons. The contract conditions require her, when running at full speed on the surface, to dive to a depth of 20 ft. within one minute after giving the order, and automatic apparatus prevents her from sinking below a fixed depth. The frame is made of angles 20 ins. apart, covered with ⅜-in. steel, with ½-in. steel armor plate on the top surface. For three-quarters of her length the shell is double, with the space between used for coal-bunkers and water-ballast, and separated by water-tight bulkheads. Inside the shell, bulkheads of ¼-in. plate divide the vessel into seven compartments. Triple expansion engines will propel twin screws, and coal will be used for fuel when running at the surface, and electric power when the boat is submerged. She will be provided with horizontal as well as vertical rudders and a vertical screw will assist her in descending. The contract speed is 15 knots per hour at the surface, with only her superstructure visible; with 3 ft. of water over the hull the speed is to be 14 knots, and 8 knots when completely submerged. Air compressed to 200 lbs. per sq. in. will supply the crew of 6 or 8 men when the boat is beneath the surface and the electric storage battery will supply light. The capacity of the storage battery is sufficient for a 6-hour run at 8 knots speed beneath the surface. The armament will consist of automobile torpedoes and two 8-in. expulsion air-tubes fitted to throw a 150 lb. projectile 500 ft. by the force of compressed air. All that appears above the upper surface of the boat is a small armored turret, for the pilot, and a smoke-stack. Both ends of this cigar-shaped vessel would be protected by tips of solid manganese bronze, 5 ft. 8 ins. long. The contract price of this invention of Mr. John V. Holland is $150,000, and he is under $180,000 bonds that his vessel shall fulfill all requirements named in the contract.

THE HATHAWAY HIGH EXPLOSIVE has been lately tested at Sandy Hook, by firing 5 shells loaded with this compound, from a Driggs-Schroeder 6-pounder rapid-fire gun. Full powder charges were used to propel the shells, and 4 of the projectiles penetrated a 4-in. test plate and exploded in the sand-bank in the rear of the target. To show the safety of this explosive the fifth shell was fired without a detonator, and while it penetrated the shell it did not explode. This explosive is claimed to be 5% more powerful than No. 1 dynamite.

EXPERIMENTAL ENGINEERING STATIONS, to be established at state colleges now receiving aid from the government for the maintenance of agricultural experiment stations, are proposed in a bill introduced into the Senate by Mr. Hale, of Maine. The purpose of these stations would be to promote investigation and research into steam and naval engineering and naval architecture. The detail of engineer officers to such stations is already authorized by law, and the bill would appropriate $10,000 per annum for 15 years, from the beginning of the fiscal year of 1897, to each college establishing such a department. The natural query is: Would not the end in view be better and more efficiently served by concentrating the money, apparatus and trained investigators in a single thoroughly organized and excellently equipped station, such as has been recommended by the Chief of the Bureau of Steam Enginering, Commodore Geo. W. Melville.

AT THE CIVIL SERVICE EXAMINATION, on Jan. 25, of candidates for positions on the New York State Engineer's staff, 23 assistant engineers passed and 13 failed; 14 rodmen passed and 44 failed, and 29 levellers passed and 24 failed.

A NEW TYPE OF CONTINUOUS CURRENT DYNAMO.

By Louis Baldwin Howell.
(With inset.)

In the development of continuous current dynamos, few radical changes in design have been made since the standardization of the ordinary types now manufactured. Minor details have been made the subject of considerable study and alteration and there has been a constant tendency toward the production of larger units, but aside from this normal growth and improvement, little attempt seems to have been made to remedy certain evils, which perhaps have been considered

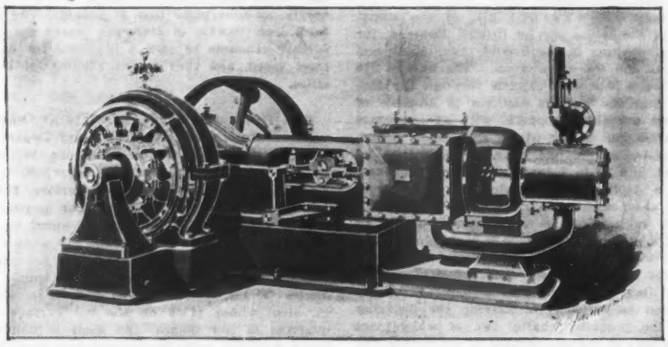


FIG. 1.—THOMPSON-RYAN DYNAMO, DIRECT-CONNECTED TO McEWEN HORIZONTAL ENGINE.

inherent with continuous current machines. Armature reaction, or the counteraction of the magnetism produced by the armature ampere turns, is a property of the ordinary form of dynamo which carries with it many evils, making sparkless commutation impossible and compelling certain limitations in design, whose absence would permit of the production of a more efficient machine.

A distinctively new type of continuous current generator, embodying as its essential feature a set of "balancing coils" designed to eliminate armature reaction, is that illustrated in these columns and in the inset sheet accompanying this issue. The use of balancing coils for the above purpose is the invention of Prof. H. J. Ryan, of Cornell University, and its practical application was effected by Mr. M. E. Thompson, who has spent five years in bringing the new dynamo to its present state of development.

In general appearance the machine is very compact, as shown in Fig. 1, where it is shown direct connected to a horizontal engine. In Fig. 2 are shown the field, armature and commutator parts, (7) is the field ring proper, containing the magnet cores, which are seen to be exceedingly small. Within the field ring fits the " pole ring," illustrated at (5). It is cored to receive the balancing coils, which are built up of copper ribbons, as shown at (6). In the illustration of the field parts in the inset sheet the pole ring is in its proper position within the field ring. The field parts are steel castings. In addition to discharging their duty of preventing armature reaction, the balancing coils take the place of a compound winding.

The armature, ready to receive its copper, is shown at (8), and in a completed condition at (9). These two figures show also the method of attachment of commutator to shaft. This construction is shown more clearly in the longitudinal section of the armature and commutator on the inset sheet. The shortness of the armature and its depth of the slots are its principal features. The laminated core is built up of thin plates of steel possessing peculiar non-hysteretic qualities, this fact, coupled with care in construction, insuring a small core loss. Cool running follows naturally from a small core loss and a large cross-section of copper, but it is made doubly sure in this case by good ventilation, resulting from a large shaft opening through the core and a system of winding at the armature heads, which causes a thorough circulation of air.

The brush-holder ring is shown at (10). It consists of three parts, a cast-iron ring attached to the field frame by iron brackets, and two rings of brass concentric to and within the first named. To the latter are bolted the brush-holders, positive and negative, each to their separate ring. Adjustment of the brushes around the commutator is secured by shifting the outer cast-iron ring, which is so fastened as to allow of this movement. This adjustment is made for a change in the compounding. The commutator is built up of tempered copper and mica, and attached to the armature core as above explained.

The results of an exhaustive series of tests and the performance of the generator in service, have led the manufacturers to claim for it many advantages, a few of which are:

(1) Small fixed losses and a wide range of economical operation.
(2) Sparkless commutation.
(3) Operation with safety under excessive loads.
(4) Extreme lightness.

The smallness of the fixed losses is due to the small amount of iron in field and armature core. A minimum armature core loss has been attained, and it is stated that the field loss averages but 25% of that of any other machine having equal capacity. The result is that the type of generator under discussion has a wide range of economical working, and possesses unusually high efficiencies under light loads. The dynamo designed after the usual practice, with its heavy fixed losses, requires for economy of operation a fairly constant load approximating its rated capacity. On the inset sheet will be found a graphical representation of the above points. The ordinates of the curves show efficiencies and kilowatt output or load is given by the abscissas. The upper curve shows the action of a Thompson-Ryan machine of 100 K-W. capacity, and the lower curve that of a 100 K-W. dynamo of standard make. It will be seen that while the efficiencies at full load are nearly the same for each, the curve of the Thompson-Ryan machine falls off but 6% between full load and 20% thereof while the curve for the other machine falls off 14%. The Thompson-Ryan machine will run at 30% full load with an efficiency but 3% less than at its rated capacity.

Sparkless commutation is a result of freedom from armature reaction and of the introduction of what is called the "commutation lug." The condition required in order that commutation may be perfect is that the magnetic field through which is passing the coil short-circuited at moment of commutation, i. e., the commutation field must vary in intensity with the load on the dynamo. It is obvious that with armature reaction and the attendant distorted field present, this condition is impossible of fulfillment. Neither will the absence of distortion in the field produce the desired result, evidently, and recourse must be had to a special means. Turning to Fig. 3, the various parts involved will be seen diagrammatically represented. The balancing coils are wound through the openings m, n, k, l, o, and p, with the commutation lug g at their center. Ordinarily there would be a space between h and i. This space the commutation lug bridges over. As shown by the dotted lines, the magnetic flow now has two paths before it. These two are so adjusted that with a light load the flow is the same through each. With heavy loads the current in the balancing coils increases, and sets up a magnetic field which strengthens the flow through the lugs beneath c, weakens that through the lugs beneath d, and in addition causes a flow through g. Thus it is seen to be possible by proper adjustment of balancing coils to produce a field of commutation (between r and s) whose intensity shall always be proportioned to the load, assuring sparkless commutation without the necessity of shifting brushes.

(3) An unusual ability to stand over-loads is the result of the large cross-section of copper on the armature and the thorough armature ventilation.

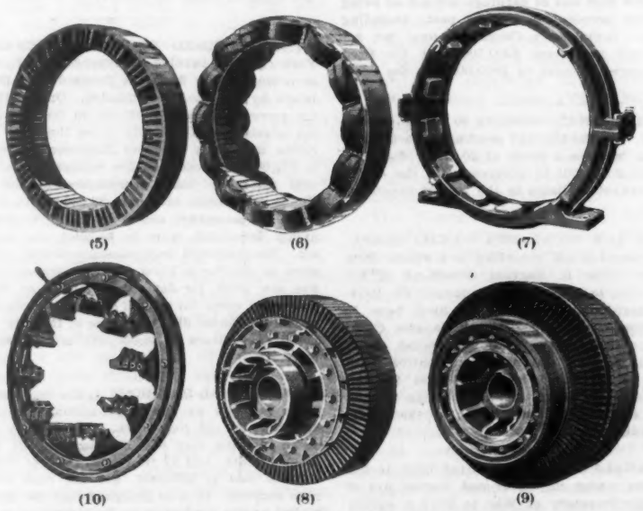


FIG. 2.—FIELD, ARMATURE AND COMMUTATOR PARTS OF THOMPSON-RYAN DYNAMO.

(4) The output per pound of weight averages from 15 to 20 watts for the direct-connected machines, which is from two to three times as great as that of any generator of ordinary type. This large output results from the great amount of copper on the armature, combined with a light field and armature core.

The Thompson-Ryan dynamo is manufactured by the J. H. McEwen Mfg. Co., in its works at Ridgway, Pa.; the New York office is at 26 Cortlandt St.

THE PROPER DESIGN FOR THE INTERSECTION OF TWO CIRCULAR RRICK SEWERS.

(With inset.)

In our issue of Feb. 6 a communication appeared regarding the proper design for the intersection of two brick sewers, at an angle of 35°, one being 14 ft. and the other 9 ft. in diameter. A number of responses have been received to Mr. Ruhm's request for information, which we give below with some illustrations. The first is from Mr. Kenneth Allen, of Baltimore, as follows:

Sir: In answer to the correspondent in your issue of Feb. 6, regarding "The Proper Design for the Intersection of Two Circular Brick Sewers," I would say:

The angle between center lines should, preferably, be nil. That is, the center line of one should become either tangential or parallel to the other by an easy curve if possible. The angle referred to, however, is presumably that between intersecting spring-lines. The quoin formed by the masonry at this point is generally too acute to be easily and substantially built of brickwork, for which we may substitute a wedge-shaped block of either cut stone or Portland concrete whose flat top is at or near the spring level.

A trumpet or bell-shaped arch is generally thrown over both sewers from the intersection of their centers to a point a short distance above the intersection of spring lines—say at the intersection of extrados; but as in the case referred to the outer surface of the arch would rise some 16 ft. above the spring, it would be well above ground and require modification. This may be effected by flattening the arch to a certain extent, depending on: (1) The proposed flood level in the sewers, and (2) the proximity to the surface, with the resulting loading to which the arch might be subjected. A well-built arch of brick or Portland concrete with heavy spandrel backing may be employed under moderate conditions, but otherwise recourse may be had to a chamber with sides plumb above the spring line, roofed with flat arches thrown between steel I-beams, as in floor construction.

In the case of a flattened or elliptical arch the specifications and designs would both be open to criticism if they failed to provide for the increased liability to tension from excessive loading. Yours truly,

Kenneth Allen.

Office of Sewerage Commission,
Baltimore, Md., Feb. 8, 1896.

The next letter received was from Mr. E. H. Bowser, of Louisville, Ky., and is accompanied with a sketch showing the problem solved by the use of I-beams and jack arches. Mr. Bowser writes as follows:

Sir: In your issue of Feb. 6, Herman D. Ruhm asks for information regarding the intersection of brick sewers. I judge from his questions that he intends to connect the sewers directly. This would not only be a very difficult thing to do with brick, but at an intersection angle of 35° (or any other angle suitable for sewer connection), the irregular groin would offer a very imperfect resistance to the pressure brought upon it, and I doubt if it would stand for any length of time.

Mr. Ruhm is evidently not familiar with the "bell-mouth" connection, which, I believe, is almost universally used in cases of this kind, except where the brick sewers are small and it is convenient to connect them at a manhole. This method is better for small angles of intersection than it is for large ones, and gives a perfect arch resistance to the pressure from above. The sewers mentioned by Mr. Ruhm are very near the surface, with only 2 ft. of backing, and unless there is some insurmountable difficulty, should be placed deeper. On account of the small depth of the backing, it would be impracticable to build an ordinary bell-mouth, as its crown, if arched sufficiently to give the proper strength, would necessarily be higher than the crown of the large sewer.

I attach a sketch (Fig. 1) which is meant merely as a suggestion as to how the difficulty of a high crowned bell may be overcome. Below the spring line the bell is made in the ordinary way. Above the spring line, the walls, instead of being arched across the opening, are built straight up to the height of the intrados of the large sewer. On top of these walls, across the bell, I-beams are laid and the spaces between the beams filled with brick arches backed with concrete. This method, of course, is the same as that which is commonly used for floors. The crowns of these arches should not be made higher than the crown of the 14-ft. sewer, although it may be necessary to have the tops of the I-beams somewhat higher at the large end of the bell.

In the accompanying sketch I have brought the bottoms of the sewers to the same grade, which I think is the best practice. The grade of the smaller sewer should be made steeper just before it reaches the wall of the bell.

In the Engineering News of May 10, 1894, Mr. Ruhm will find cuts of two examples of bell-mouth intersections, although the sewers are not circular in either case.

Yours truly,

E. H. Bowser.

Louisville, Ky., Feb. 10, 1896.

Perhaps some of our readers will be surprised to see how a member of a present-day class of engineering students will solve the problem. Such a solution is presented with the following letter from Mr. Henry Ogden, the drawings having been made by Mr. Dean Clark:

Sir: As an interesting application of the work on intersections with which my classes in descriptive geometry (at Cornell.—Ed.) happened to be busy, I gave them to work out and bring in to me the problem submitted by your correspondent in your issue of Feb. 6 on the intersection of two circular sewers. I send you one of the solutions (Fig. 2) showing the shape of the tongue between the two sewers and the angles required of the brickwork. The question of your correspondent would seem to be settled by a study of such a drawing, and, with no special provision in the specifications, a careful inspector should have brickwork laid in such conditions with entire safety. Henry N. Ogden,

Chief Engineer, Ithaca Sewer Commission.

Ithaca, N. Y., Feb. 14, 1896.

Complete drawings of an intersection made in actual practice at Philadelphia have been sent by Mr. Geo. E. Datesman, of Philadelphia, who writes as follows:

Sir: I forward herewith blue-print showing a junction chamber, combining the flow of two sewers in a larger main sewer, similar in size to those for which a Nashville correspondent of your paper was seeking information in your issue of Feb. 6. Yours truly,

Geo. E. Datesman,
Principal Asst. Engr., Bureau of Surveys, Department of Public Works.

Philadelphia, Feb. 21, 1896.

This intersection is on what is known as the Wingohocking sewer at 18th St. and Bellfield Ave. The drawings are self-explanatory.

SIZE AND CAPACITY OF FREIGHT CARS FOR INTERCHANGE TRAFFIC.

We give herewith an abstract of the very full report of the special committee on "Large Cars," presented and discussed at the meeting of the New York Railroad Club on Feb. 20, and have discussed the subject editorially in another column.

Within 20 years the capacity of the average freight car has been increased threefold. For many years, say from 1855 to 1876, the standard capacity was 20,000 lbs. About 1879 the principal East and West trunk lines commenced to construct cars to carry 40,000 lbs. About 1883 the 50,000-lb. car made its appearance, and about 1889 the 60,000-lb. car, which is now considered the standard. Within the past year the Lake Shore & Michigan Southern Ry., the New York, Pennsylvania & Ohio R. R., the Pennsylvania Co., and perhaps a few others, have added some 80,000-lb. coal and ore cars to their equipments.

The main reason for the continued growth of car capacity is found in the necessity for increased economy in the transportation of freight. One of the best understood principles of railway economy is that of moving a given quantity or a given tonnage of freight with the smallest possible number of cars and trains, within certain reasonable limitations. A pertinent point for consideration at this time is whether the modern freight car has now reached the maximum profitable limit of its dimensions and carrying capacity, from an economic standpoint. The following table shows the relative increase in dead weight of car and weight of paying load, and the percentage of each to the total loaded weight:

Year.	Weight of car.	Weight of load.	Total weight hauled.	Wt. of car to total wt.	Pay load to total wt.
	lbs.	lbs.	lbs.	%	%
1876.....	20,500	20,000	40,500	53.62	46.38
1882.....	24,000	40,000	64,000	37.50	62.50
1890.....	27,700	60,000	87,700	31.59	68.41
1895.....	32,000	70,000	102,000	31.37	68.63
1895.....	36,000	80,000	116,000	31.04	68.96

Assuming that these cars are loaded to their full capacity, the benefit of the large increase in the proportion of "paying load" to "total load," and the large decrease in the proportion of "dead weight" to "total load," is too obvious for comment. It seems, however, hardly probable that any further advantage can be gained in the construction of wooden cars of a greater capacity than 70,000 or 80,000 lbs., and future development must come from the increased use of metal in car construction, by which it may be possible to further increase the paying load and decrease the percentage of dead weight.

The economy of large cars depends, of course, upon the extent to which they can be made to carry full loads, keeping the proportion of dead weight at the minimum. It must be admitted that in this respect there is some difference between box cars and open cars, owing to the distinctive characteristics of the traffic to which they are adapted. The usual arguments in favor of large capacity cars may be applied unreservedly to those cars that habitually move with full loads, and only to a limited extent to those cars that frequently carry light loads which do not reach the limit either of cubic or tonnage capacity.

Upon certain classes of light and bulky articles the carrying capacity of cars is limited by the dimensions of the car bodies, in other words, by the number of cubic feet of inside space available. Upon other classes of freight the carrying capacity of the cars is limited, not by the dimensions of the car bodies, but by the strength of the axles, the running gear, the car bodies, and frames, and by strength of the permanent way, bridges, etc. With such heavy freight the cars may be loaded to the limit of their tonnage capacity; but when covered cars are used there is a large proportion of their cubic capacity unfilled. About 75% of the total tonnage is of such a character that it may be loaded up to or beyond the full weight capacity of the cars. Although it is assumed that cars are built primarily for the use of the road owning them, they cannot, under present conditions, be kept exclusively in the possession of their owners. The aim should be to build cars adapted to the general service on all or a majority of the principal railways. Each road forming part of a through line has a right to demand that the cars of other roads which it receives in exchange for its own shall conform to some accepted standard, suited to the general requirements of the through traffic.

A form of competition exclusively indulged in by the carriers at the instigation of the traffic departments is the building of extra large box cars for the handling of light and bulky freight. The demand for these extra large box cars was inaugurated and is still being stimulated by the provision in the official classification establishing minimum carload weights of light and bulky articles, for which shippers must pay whether the car offered by the carrier is a large or a small car. As the shipper who gets a small car knows he will have to pay more per 100 lbs. or per package than the one who gets a large car, it is quite reasonable and natural that all shippers of light and bulky freight should demand the largest cars to be had. This demand will doubtless continue until the classification is changed. The simple and natural remedy for this would seem to be the establishment of a rate unit for light and bulky articles that will make no discrimination between the use of small and large capacity cars.

For a wooden car, with wooden bolsters, it is doubtful if a substantial car of more than 40,000 lbs. capacity can be constructed within the limits of space available, and it is recommended that on all cars of a capacity of more than 30,000 lbs., no wooden bolsters be used. Beyond this capacity, the car becomes composite in its construction, and it is the first and natural step in the development of the iron car. The essential features of a satisfactory body bolster for a car of 60,000 lbs. capacity, are that it should be stiff enough to carry the running strains imposed by a load of 30,000 lbs., plus one-half the weight of the car, and not deflect enough to bring the side bearings into contact.

As to the framing, the practice varies very considerably. We find cars built with sills ranging from 4×8 ins. to 5×14 ins., which in itself makes a variation of from 1 to 3¾ in their supporting power; and truss rods varying from four of 1 in. diameter to six of 1½ ins. diameter, and that, too, for cars of the same nominal capacity, showing that guesswork extends beyond the domain of the designing of the body bolster. Truss rods should be so proportioned that they are capable of carrying the whole of the static weight that would naturally fall upon them, and the upper framing should have sufficient strength to sustain the extra stresses put upon the car while running.

Regarding the desirable length of cars, for wooden framing, a length of 36 ft. inside ought not to be exceeded. Of iron framing, we are not in a position to speak.

Observation of the amount of repairs required by these large cars indicates that the proper proportional strength of high cars has not been attained, particularly where the cars are more than 34 ft. long. Wide cars also develop many weaknesses, especially in the bolster, where the width is more than 9 ft.

Truck construction has outstripped the body construction, so far as strength is concerned, to such an extent that it requires but passing notice. The steel bolsters and transoms used seem to be fully up to the requirements of the traffic; but there is an evident desire to secure something better than the diamond truck. The use of a central truck is inadvisable, except in special cases.

As to car maintenance, your committee is of the opinion, though no actual figures are available, that the expense of maintenance per car per ton hauled is much diminished by successfully carrying 30 tons instead of 10 tons in one car.

It has been shown that brakes are best adjusted when the pressure of the shoe against the wheel is 70% of the weight of the wheel upon the rail. As this adjustment

must necessarily be made for an empty car, it follows that the braking efficiency falls as the load in the car increases. If a car weighing 30,000 lbs. can be stopped in 600 ft. when empty, it will run approximately 1,200 ft. with a load of 30,000 lbs., and 1,800 ft. with 60,000 lbs., so that the speed of the loaded train must necessarily be lower than the empty one, if the same control is to be maintained.

To summarize this portion of the report: (1) for cars of 60,000 lbs. capacity and over, it is best not to exceed a length of 36 ft., inside measurement; (2) the main dependence for the vertical strength of box cars should be placed in the truss rods; (3) steel bolsters should invariably be used; and (4) the side bearings should always have a clearance.

The proposed standard car body for roofed cars, to make them equally available for the carriage of light bulky freight and heavy freight, should have an available inside cross section of not less than 65 ft., and not more than 75 ft.; and an inside length of not less than 34 ft. and not more than 36 ft. Within these limits the storage capacity would be from 2,210 to 2,700 cu. ft., the latter of which appears to be ample for any class of freight handled in box, stock or refrigerator cars.

The withdrawal from the interchange service of all four-wheel cars, and of all eight-wheel cars of less capacity than 40,000 lbs., would not be an injustice to any road; and with respect to roofed cars, whose cubic capacity is a factor of consequence, the additional line for exclusion from interchange might well be drawn upon all cars of less than 30 ft. in length, inside measurement, and of a storage capacity less than 1,500 cu. ft. The owners of the small cars could then keep them in local service on the same road during the short remaining period of their existence. To make this recommendation effective a suitable rule should be added to the Master Car Builders' rules of interchange. Such a reduction of the existing great diversity of cars in interchange should be one of the first steps towards the attainment of a standard car for general service.

For general interchange service there should be fixed by convention a minimum limit, and a maximum limit of weight carrying capacity for all classes of cars. Few, if any, cars of a capacity less than 40,000 lbs. have been built during the past 13 years; and those of a smaller capacity now in existence are nearly worn out. In determining the probable economic limit of the relative maximum weight capacities of roofed cars and open cars, of wooden or composite construction, it is not apparent that much is to be gained by exceeding a capacity of 70,000 lbs. for the former, and 80,000 lbs. for the latter. It is therefore recommended that these maximum limits be agreed upon, and not in any case exceeded until the roads change them by further mutual agreement. If no cars of a greater capacity than 70,000 or 80,000 lbs. are permitted to go into the general interchange, it is safe to say that the problem of the weights of loaded cars upon track and bridges will not become a disturbing factor.

Principal Outside Dimensions of Large Roofed Cars.

Owner.	Carrying capacity.	Length over sills.		Width over eaves.		Height rail to eaves.	
	Lbs.	Ft.	In.	Ft.	In.	Ft.	In.
C. & G. T. (Furniture)...	60,000	40	4	9	7	12	2½
C., B. & Q. (Furniture)..	50,000	40	..	9	9¼	12	6½
C., R. I. & P. (Furn.)	50,000	40	11	9	9	12	9
C. & O. (Stock).....	60,000	..	..	10	..	11	4
Ill. C. (Furniture).....	60,000	45	7½	10	1⅝	12	11
L. Val. (Poultry).....	60,000	36	10½	9	9	12	1¼
L. & N. (Furniture).....	60,000	40	7⅝	9	9	12	2½
Minn & St. L. (Refrig.).	50,000	34	4½	9	11¼	12	..
" " (Furn.) ..	60,000	41	..	9	9	12	6
Mans'r & Tebb'ts Imp. Co.	40,000	60	5	10	..	13	5
C., N. O. & T. P. (Vent'd).	60,000	34	11¾	9	9½	11	6
Pa. Co. (Union), (Furn.)..	60,000	42	7½	9	5	12	4⅜
Wabash R. R. (Furn.)...	40,000	45	6	10	6	..	..
Nor. Pac (Grain).....	70,000	42	..	9	11⅛	11	9

Discussion.

This report called forth a general discussion, very generally endorsing the views and recommendations of the committee. The following is an abstract:

Mr. Chamberlain said that many Eastern roads have tunnels, low bridges, etc., built for the cars of 20 years ago, and such roads sometimes experience a good deal of trouble from the large furniture cars now in use. As to larger carrying capacity, he considered 60,000 lbs. should be the limit for ordinary freight traffic, but that for special cars such as ore or coal cars, or cars running regularly between two points, the capacity may be 70,000 or 80,000 lbs. Bridges, track and the maintenance of way work must also enter into consideration. Mr. A. E. Mitchell (Erie R. R.) considered that an increase in the length and capacity of box cars might increase the earnings and reduce the operating expenses as far as the transportation side of the question is concerned, though the additional cost of maintenance of way might make the net results very different. He compared a 34-ft. box car of 60,000 lbs. capacity, weighing 30,000 lbs; with a 38-ft. box car of 80,000 lbs. capacity, weighing 34,000 lbs. In a train of given capacity, the dead load would be but little increased by the use of the larger cars, while the number of cars, axles and journals would be considerably reduced.

Mr. E. E. Russell Tratman, of the editorial staff of this journal, corrected the statement in the report that no box cars of over 60,000 lbs. capacity have been built, and referred to the use of 70,000-lb. grain cars, 42 ft. long, weighing 32,000 lbs., on the Northern Pacific R. R. (Eng. News, Feb. 20, 1896). In regard to the question of damage to the track he did not consider that the damage due to the cars (or trains exclusive of engines) would approach that due to the locomotives, owing to the greater wheel loads, the greater concentration of the loads, and the destructive effects due to bad counterbalancing, and the wear by sand and slipping wheels. The 70,000-lb. freight cars, weighing 102,000 lbs. with full load, have axle loads of 25,500 lbs., but the ordinary freight car axle loads are from 16,000 to 20,000 lbs., while locomotives have axle loads of 25,000 to 39,000 lbs., and frequently have three or four such axle loads concentrated on a short wheelbase. As to the track, he believed that on many roads the track is far below the requirements of economy and safety for existing car and train loads.

Mr. Mendenhall (Pennsylvania R. R.) said that he had calculated the strains on the truss rods of the Northern Pacific R. R. car, above referred to, and found that the four 1⅛-in. rods were not enough to carry the strains, while six rods would be but little in excess of the requirements. One member stated that a private car line of California had recently had many of its cars tied up on various roads in other states, owing to their size being beyond the clearance limits, and another member stated that he considered 25 tons to be the average car load, and to be therefore the practical limit for which cars should be built. Mr. Wheatley said that it is quite as necessary for equitable interchange service to take the existing small cars out of service as to prevent the introduction of very large and heavy cars. He gave figures as to car and train loads, showing car loads of 30 to 36 tons for box cars, the paying load being 62 to 67% of the total load. The committee's report recommended 70,000 lbs. as the limit of capacity for a box car, and as it had been shown that cars of such capacity are in actual service he did not think it would be well to put the limit any lower. Another member said he did not think that sufficient credit had been given to the framing of a well-built box car to sustain part of the load. On the Pennsylvania R. R. such cars are built to have a camber in the floor before the truss rods are set up. Mr. Wattson (West Shore R. R.) referred to the practice of some roads owning small cars in sending out such cars for interchange service and retaining large cars from neighboring roads for their own local service. This was one proof of the necessity of taking such small cars out of service for interchange traffic. He considered the report an excellent one, and thought the club should go on record with some expression of opinion as to its conclusions.

Mr. West (Ontario & Western Ry.), the President, also considered that some action should be taken upon the conclusions presented in the report, and appointed a committee to prepare an appropriate resolution. At the close of the meeting the committee presented the following resolution, which was adopted:

Resolved: That it is the sense of the New York Railroad Club on the question of large capacity cars for general interchange service, that box and stock cars shall not be built to exceed a capacity of 60,000 lbs., and that this club earnestly recommends to the traffic associations that in making their rates on light, bulky freight, such rates shall be based on the cubic capacity of the car.

SPECIFICATIONS FOR ASPHALT RESERVOIR LININGS AT PHILADELPHIA.

Specifications for relining the Queen Lane and Roxborough reservoirs at Philadelphia have been prepared, and bids for the work will be received until March 26. For each reservoir bids are invited for an asphalt paint lining, with and without the use of burlap, and also for a watertight lining under any plan proposed by the bidder. For the Queen Lane reservoir bids are also wanted for an asphalt-concrete lining. The slopes of the reservoirs are to be lined and perhaps a part or a whole of the floors. Each reservoir has earth embankments lined with clay, the Queen Lane being protected by a concrete lining on floor and slopes, and the Roxborough by concrete on the floor and brick in cement on the slopes.

The Roxborough reservoir is designed for a capacity of 147,000,000 gallons and a water depth of 25 ft., and Queen Lane for 383,000,000 gallons capacity and 30 ft. depth. The relining of each structure is necessary on account of leaks. In our issue of Aug. 8, 1895, we published an abstract of a report on defects in the Queen Lane reservoir, made by Messrs. John C. Trautwine, Jr., Chief of the Bureau of Water, Rudolph Hering and Maj. C. W. Raymond, U. S. A. This commission recommended an asphalt lining, a concrete foot wall and certain other work. The concrete foot wall, as put in for one of the basins, was illustrated and described in our issue of Oct. 24, 1895. Specifications are now ready for the other work recommended in the report, including the lining, the foot wall in the other basin, a retaining wall and reconstruction of the outer slope of the reservoir and a drain around the structure.

So far as we know, these are the first specifications for asphalt reservoir lining on a large scale in the East. That portion of the specifications relating to the asphalt paint lining of the Queen Lane reservoir, and the preparation and application of the asphalt is as follows:

Character of Asphalt.—The asphalt shall be a natural asphalt, or a mixture of natural asphalts, containing, in its refined state, not less than 90% of bitumen soluble in rectified carbon disulphide or in chloroform. The remaining ingredients shall be such as to exert no injurious effect upon the work. Not less than two-thirds of the total bitumen shall be soluble in petroleum naptha of 70° Beaume or in acetone. The asphalt shall not lose more than 5% of its weight when maintained for ten hours at a temperature of 300° F.

The use of coal tar, petroleum residuums, or so-called artificial asphalts will not be permitted in any portion of the work or in any of the mixtures to be used.

Asphalt Priming Coat.—The concrete surface of the slopes and of the floor, all of which must be clean and dry, shall be carefully freed from all small projections which might penetrate the asphalt coating or render it sensibly deficient in thickness in places.

It shall then be painted with a solution of 30% refined asphalt in 70% of benzine of 62° B. gravity. No admixture of heavier oils shall be permitted for the purpose of attaining to this standard. Any portions of the priming coat, which, in the judgment of the engineer, have become injured, by exposure or otherwise, before the application of the paint coat, shall be restored by the contractor.

Asphalt Paint Coat.—The asphalt for the paint coat shall be melted, and shall then be maintained at such temperature and for such length of time as the engineer may direct. During that time it shall be continuously stirred, so as to acquire uniform consistency and to avoid danger of burning. Any asphalt which has been burned shall be rejected. The priming coat shall be clean, warm and dry when the asphalt paint coat is laid upon it.

The asphalt paint shall be poured, at such temperature as the engineer may direct, upon the primed surface, and spread, with brooms or brushes, to a uniform thickness, which shall not be less than 1-16-in., but shall be as near that thickness as possible, and not greater than ⅛-in. The edges of all work that has cooled shall be properly heated when new material is laid in contact with them.

Special pains shall be taken to secure a perfect filling of the joint between the top of the slope and the present Neuchatel pavement, and the lining shall extend downward from that joint to the feet of the slopes, and as far out upon the floor as the director may require.

The surface of the asphalt, while still hot, shall be sprinkled with fine quartz sand or hydraulic cement, or with a mixture of the two, at the option of the engineer, and this powder shall be worked into the surface with wooden floats in such a manner as to give a smooth, uniform appearance, resembling that of a plaster finish of cement and sand.

Repairs of Cracks in Present Floor Lining.—All cracks in the present concrete floor lining shall be cleaned or opened out, as may be directed by the engineer, treated with the priming coat and filled with asphalt, or asphalt concrete, as he may require, and to his satisfaction.

The specifications for the asphalt lining with burlap are substantially the same as those given above in the matter of the character and application of the asphalt, with the exception, of course, of the provisions for including the burlap. This is to be secured at the top of the slope in a groove 2 ins. wide by 1¾ ins. deep by fastening the burlap to wooden strips 1½ ins. square, placing these in the groove, and later filling the space remaining with asphalt. The burlap is then to be stretched over the asphalt priming coat while the latter is hot and "thoroughly rolled or tamped into it." The second asphalt coat is then to be spread over the burlap and thoroughly rolled into it "by means of hot rollers, or pressed into it by such other means as the engineer may select."

The floors of the reservoirs or such portions of them as the engineer may direct are to be treated with two coats as provided for the slopes, but without the use of burlap.

The contractor must maintain the work in good

shape for five years, making all necessary repairs at his own expense. To protect the city in this matter 5% of the cost of the work will be retained after its completion to be paid in equal annual installments, provided the contractor properly maintains the lining; otherwise the engineer will make the repairs and charge them against the sum retained.

The specifications for asphalt work in the asphalt concrete lining are practically the same as those for the two asphalt coats without the burlap, with the exception that not quite so much paint is required to thoroughly cover all concrete projections with the first coat of asphalt, and that the sand or cement finish is not required for the second coat.

The asphalt concrete is to be applied to the top of the second coat of asphalt, and is afterwards to have an asphalt paint coat. The specifications for this work, slightly abbreviated, are as follows:

Asphalt Concrete.—The asphalt concrete shall be composed of the melted asphalt and broken stone.

The largest of the pieces into which the stone is broken shall pass through a 1½-in. ring and shall not be more than 2½-ins. in length. The stone shall be used as it comes from the crusher and without screening; and gravel, sand and dust shall be added to it in such proportions as the engineer may direct.

The broken stone, with its admixture of gravel, shall be heated, in iron pans or kettles, to such temperature as the engineer may direct, and the melted asphalt shall then be poured over it, in such proportion as to ensure the covering of each particle of stone, etc., with asphalt, and the whole mass shall be thoroughly incorporated.

The concrete thus formed, while still hot, shall be laid in place in such manner as to avoid disintegration of its mass, and thoroughly tamped or rolled, or both, in the discretion of the engineer, to a final thickness of 3 ins.

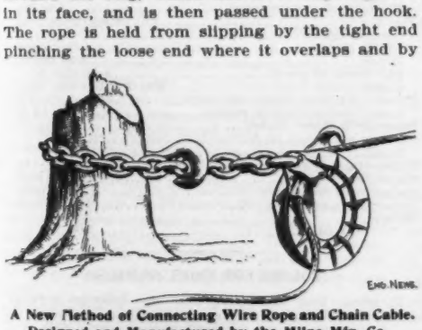
If required by the engineer, the asphalt concrete shall be applied while the first asphalt paint coat is still hot, or the latter shall be heated to receive the asphalt concrete.

Second Asphalt Paint Coat.—The second asphalt paint coat shall be similar to the first in composition, and shall be applied in the same manner and while the surface of the asphalt concrete is still hot; or, at the discretion of the engineer, the surface of the asphalt concrete shall be heated to receive the second asphalt paint coat, and the latter shall in any case be tamped, rolled or smoothed, at the discretion of the engineer, with hot irons and while it is still hot.

This lining must also be maintained for five years by the contractor, as outlined above.

A NOVEL WIRE ROPE COUPLER.

We illustrate herewith a very simple device for attaching a wire rope to a chain and hook, such, for instance, as is used in pulling stumps, or in house-moving outfits. As will be seen, the rope is inserted in the notch and brought once around the ring, which has a V-shaped groove in its face, and is then passed under the hook. The rope is held from slipping by the tight end pinching the loose end where it overlaps and by



A New Method of Connecting Wire Rope and Chain Cable. Designed and Manufactured by the Milne Mfg. Co., Monmouth, Ill.

the friction in the V-shaped groove. It will be noticed also that with this coupler the chain and hook can be attached to the rope at any point along its length, thus doing away with the necessity of shortening or winding up the rope. Of course the coupler can be used fastened stationary to a post or beam and in many other positions which will at once suggest themselves to the engineer. This coupler is manufactured by the Milne Mfg. Co., of Monmouth, Ill., and was especially designed for use on its all-steel stump pulling machines.

TWO DAYS IN WORCESTER, MASS.

(Editorial Correspondence.)

Worcester is known to most travelers between New York and Boston merely as a stopping place on the Boston & Albany R. R., 44 miles west from Boston, which contains a large Union depot, built of stone, with imposing architectural features. Engineers are acquainted with it as a place from which come wire and wire-rope, and as the location of the Worcester Polytechnic Institute, one of the oldest of American engineering schools. Your correspondent had an opportunity to spend two days in the city recently, with unusual facilities, afforded by the courtesy of friends, for making observations and taking notes, and found it a much more interesting place than he had formerly supposed. It is typical of the medium sized cities of New England, in showing every sign of increase in population, in wealth, and in the use of the comforts and luxuries of modern life. Neither the abandonment of New England farms, the competition of Southern cotton mills, nor the hard times of 1893-5 seem to have been able to stop the growth in wealth and population of the New England cities. They seem to have all the vigor of youth with the finished and steady appearance of towns in which wealth has been accumulating through generations.

The population of New England is steadily leaving the farms and going into large and medium sized cities, the small villages remaining stationary or declining. Perhaps this is an evil, but if so, the appearance of the people and of their houses in Worcester does not indicate it. The workmen have plenty of work, fair wages, and comfortable homes, and probably enjoy life more than they could do on the farms of their fathers.

According to the state census of 1895, the population of Worcester was 98,767. By the United States census of 1890 it was 84,655, and by that of 1880, 58,291, showing an increase in the census decade of 45.23%. That such a rate of increase is not exceptional in Massachusetts is shown by the following figures of population of the six largest cities in the state.

Population of Six Massachusetts Cities.

	1895.	1890.	1880.	Increase. 1880-1890.
Boston.....	496,920	448,477	362,535	23.60%
Worcester....	98,767	84,655	58,295	43.23%
Fall River....	89,203	74,398	49,006	51.95%
Lowell	84,367	77,696	59,485	30.64%
Cambridge....	81,643	70,028	52,740	32.26%
Lynn.....	62,354	55,727	38,284	45.60%

While the increase of population is thus taking place in the cities, and the total population of the state is also increasing, the figures for the state being: 1880, 1,783,085; 1890, 2,238,943; 1895, 2,500,183, the population of the country districts is in many places decreasing. Out of 351 towns into which the 14 counties of the state are divided, 141 showed a decrease between the year 1890 and 1895. The decrease is especially noticeable in the more sparsely settled towns, containing 2,000 inhabitants or less.

Writers on social questions frequently deplore the movement of the people from the country into the cities, but I do not recollect to have noticed that any of them gives the correct reason for it. It is that men build large factories in the cities. If they would build them in the country, population would stay in the country. That is the reason why Worcester grows so rapidly. Numerous large factories have been built there, and the factories draw the people. It is pre-eminently a manufacturing city. Unlike other Massachusetts cities which are noted for one product, such as Fall River for cotton, Lynn for boots and shoes, Holyoke for paper, Worcester makes a great variety of things. It is claimed that its industries are more widely diversified than those of any other city of its size in the country, and that in consequence of such diversity it suffered less from the hard times than almost any other city. It is also claimed that wealth is more widely distributed among the whole people, and that the great middle class is relatively larger, and the very rich and the very poor classes smaller than in any other city. I was not able to obtain statistical evidence of this, but from the appearance of the city and its people I can well believe it possible. Some figures gleaned from the city directory and from a little pamphlet describing the city, published in 1895, follow: The assessed valuation of real and personal property increased from $77,000,000 in 1881 to $88,000,000 in 1895. There are 1,200 manufacturing establishments, with $30,000,000 invested capital. The savings banks have $30,000,000 deposits. Of the 1,200 manufacturing establishments the great majority must of course be very small, many of them occupying only a single room in a large "power building," but there are a number of very large concerns, some of them the largest in their class in the world, such as the wire works of the Washburn & Moen Mfg. Co., the Knowles' Loom Works and the Whitcomb Envelope Co.

The Washburn & Moen Mfg. Co.—The beginning of this concern was made in 1831 by Ichabod Washburn, in a small blacksmith shop. The company now owns an extensive factory at Quinsigamond, on the outskirts of Worcester, and another at Grove St., in the city itself, established in 1842; the two together employ about 5,000 men. It has also, in 1892, built a new factory at Waukegan, Ill., and last year it purchased the Hallidie Wire & Wire-Rope Works, in San Francisco. The Quinsigamond works contain four open hearth steel furnaces, of from 15 to 20 tons capacity each, for the production of the steel from which the wire is made. For the finest quality of steel wire rods the pig iron used is imported from Sweden. One of the furnaces is a basic furnace, for the utilization of every variety of steel scrap. Besides the furnaces there are a blooming mill for reducing the ingots to 4-in. billets, and a train of continuous rolls, which take the 4-in. billets and roll them down into No. 6 wire rods, at one heat and without any hand labor other than placing the billet in the first pair of rolls.

An interesting problem in steam engineering was recently solved in these works. The 30x60 ins. Corliss engine driving the mill became too small for the increased load caused by the enlargement of the mill. Another engine, 52x60 ins., was placed near it in such a position that the fly wheels of the two engines were face to face, and 25 or 30 ft. apart, and then one Saturday night the two fly wheels were connected by a belt and the exhaust of the old engine was led through a receiver into the cylinder of the new one, so that the two engines ran together as a compound engine. A saving of fuel of about 20% at once resulted from the change. Another interesting engine at these works is a 1,000-HP. three cylinder compound Armington & Sims engine, with one 20 and two 24 in. cylinders, 2 ft. stroke, running 210 revolutions per minute. In addition to wire-rod and wire making, the Quinsigamond Works are largely devoted to the making of barb-wire and other kinds of wire fencing, the insulation of wire for electrical purposes, etc. One of the features of the works is a complete plant for the manufacture of india rubber insulating compounds direct from the imported raw rubber. At the company's Grove St. works wire drawing is the principal work, but the making of wire rope and cables is extensively carried on. Cables of copper wire for electrical purposes, both aerial and submarine, are made in great quantity. One department of the works makes flat spring wire of all kinds, for corsets, clock and watch springs, etc., and a great variety of work is done in putting the springs into shape ready for use. There is a notable engine in these works also, a Greene compound condensing of 2,000 HP., running 100 revolutions per minute, driving a belt which is probably the largest in the world, 80 in. face, 1 in. thick and 125 ft. long.

The Crompton Loom Works.—The Crompton loom, invented by William Crompton in 1837, is said to be the first loom upon which fancy cassimeres were woven by power. Improvements have been steadily made since 1866, and the loom is now the fastest made for a great variety of fine and fancy work. A great business has been built up from the success of the loom, and the works comprise a number of large and finely equipped buildings.

The Knowles Loom Works.—These works date from 1865, and they have grown to be one of the largest loom making works in the world. They claim to build a larger variety of looms than any other concern in the world. They are now busily engaged on contracts for supplying some large Southern mills. A rapid walk through some of the departments of the works gave your correspondent some idea of the immense variety of detail there is in the building of looms. Every different kind of textile fabric requires something different in the loom upon which it is made. Fash-

ion continually calls for new "weaves," and makers of goods are always seeking for improvements in speed, etc., which keeps the loom designer busy making new devices. The business of loom making has not been very prosperous during the past three years of trade depression, but it is now better than it was a year ago. The demand from the new Southern mills is the principal one at present. When the two large loom works, the Crompton and the Knowles, are busy they give employment to 2,000 men.

Brief mention only can be given of other leading manufacturing industries: Two concerns, the Worcester Carpet Co. and the M. J. Whitall Carpet Co. make Wilton and Brussels carpets, employing together 800 men. Three large concerns, the W. H. Hill Envelope Co., the Whitcomb Envelope Co., and the Logan, Swift & Brigham Envelope Co. are said together to produce about one-third of all the envelopes used in the country.

Worcester is the home of some of the earlier makers of wood-working machinery. In 1834 Thomas E. Daniels here invented his famous wood planer. A circular saw, driven by horse-power, was used here as early as 1828 by Wm. T. Merrifield. The leading establishment now engaged here in making wood-working machinery is Witherby, Rugg & Richardson. They have a large factory and make a considerable variety of machines.

There are a large number of machine tool builders in Worcester, none, perhaps, of the first magnitude, but some are of fair size. Among them are the L. W. Pond Machine Co. and the Powell Planer Co., makers of planers; Prentice Brothers, drilling machines; F. E. Reed Co., lathes and milling machines; W. C. Young Mfg. Co., lathes, shears and punches; P. Blaisdell & Co., Boynton & Plummer and Draper Machine Tool Co., tools of various kinds. The Fitzgerald Machine Co. makes meters, governors, overhead trolley ways and appliances for electric cars. Wyman & Gordon do a large business in drop-forging; the Worcester Machine Screw Co. is one of the leading concerns in the country for the manufacture of machine screws; the Coes Wrench Co. is famous for wrenches.

Corsets and Non-Condensing Throttling Compound Engines are a rather unusual combination, but it so happens that the Worcester Corset Co. is about completing a very large four-story factory building of slow-burning construction, that should be of interest to factory builders and architects as a fine example of construction, although rather expensive, and it is putting in two different kinds of non-condensing compound engines, both of which are rather novel, one to drive the machinery and the other to drive the electric lighting plant. One of the engines is a horizontal cross compound, built by Houston, Stanwood & Gamble, of Cincinnati, and the other is a double tandem vertical engine, also with throttling governor, built by the Worcester Polytechnic Institute from the designs of Mr. Geo. I. Rockwood., of Worcester. It is a small engine, rated at 75 HP., containing a number of new features, the most noticeable being a triangular beam or rock shaft which transmits the power from a small vertical link, joining it and the crosshead to the connecting rod, which in its middle position is horizontal. By this means the tandem cylinders are brought down so low that they may be reached by the oiler from the floor, and do not require any galleries or ladders. The two engines are coupled to cranks at 180° instead of 90°, as is the common practice.

Mr. George I. Rockwood, the designer of the engine, is quite a young man, a graduate of the Worcester Polytechnic Institute, who two years ago caused a considerable amount of discussion in steam engineering circles by his paper showing that a triple expansion engine, with the middle cylinder thrown out of operation, worked with about as good economy as when all three cylinders were used. He claimed from this that a two cylinder compound engine could be made as efficient as a triple expansion engine, if the ratios of the areas of the cylinders were made, say 7 to 1 instead of 4 or 5 to 1, as is common, the receiver being made sufficiently large. His proposition was condemned by most of the older engineers, but the final decision as to its correctness still waits for experimental demonstration. He certainly seems to have shown, however that by properly proportioning a compound engine its economy can be made so nearly equal to that of the triple expansion engine as to make it doubtful if the possible extra economy of the latter is sufficient to pay interest on its extra cost. Mr. Rockwood is a highly original designer, and a good feature of his designs, for the average purchaser, is that they always take into consideration the question of first cost. He has lately designed a new high duty pumping engine for small city water-works and similar uses, with the idea that an engine can be built at a low cost to give about as high duty as the very expensive engines usually built for city works.

The Worcester Polytechnic Institute.—This is one of the oldest and best known of our engineering schools. It has recently taken some great strides in the improvement of its equipment, having built new chemical, physical and mechanical laboratories, which it is now furnishing with the most modern apparatus. The shops connected with the Institute differ from nearly all other school shops in that the Russian, or pure instruction system is not adopted, but all the work done is upon actual constructions which are sold in the market. In addition to the students, who work as apprentices in the shops, there are a number of skilled workmen employed, so that the output of the shop is of a very high class, and at the same time the students get the advantage of being engaged upon actual useful work, and not merely upon models which are to be thrown away when they are finished. The new President of the Institute, Dr. T. C. Mendenhall, who has held the office for about a year, was recently the Superintendent of the U. S. Coast and Geodetic Survey, and before that was President of the Rose Polytechnic Institute at Terre Haute, Ind. He is one of the most eminent physicists in the country, as well as a man of great executive ability, and an experienced instructor, and under his administration the Worcester Polytechnic Institute will no doubt take rank with the foremost engineering colleges of the country.

Sewage Treatment in Worcester.—A very full description of the Worcester sewage purification works, which are the largest in this country in which chemical precipitation was used, was given in Eng. News of Jan. 11 and 18 and March 8, 1894. To all appearance the plant is working beautifully, if visited on a clear day when only the ordinary dry weather sewage is being treated. The effluent seems to be perfectly free of suspended matter, and so clear that the bottom can be seen in a tank 7 ft. deep. Analysis shows that on an average 90% of the suspended organic matter and about 50% of the altuminoid ammonia are removed. As stated in our issue of Oct. 10, 1895, the actual results are not quite satisfactory to the town of Millbury, on the Blackstone River, below Worcester, which has brought suit to compel Worcester to completely purify the sewage before discharging it into the river. In rainy weather, since the combined system of sewerage is used, the precipitation plant is entirely incapable of purifying the sewage, and the effluent is about as bad as the sewage. It is claimed by the Worcester people that the complaint about the river at Millbury is due to the fact that for years before the establishment of the treatment works the sludge from the sewage accumulated on the bed of the river, and it is this old sludge which is now being gradually taken up by the clean water discharged from the works which is causing all the trouble. Whether the present pollution of the river is due to this old sludge or to the imperfect purification by the precipitation works is a nice question for the experts and the lawyers to fight over when the case comes into the courts.

A COMBINATION STEAM AND ELECTRIC LOCOMOTIVE.

An electric locomotive on a similar principle to the famous Heilmann locomotive in France has been designed by Mr. L. E. Walkins, C. E., of Boston, Mass., for the Ohio River, Madison & Central Electric Railway, which is to extend from Madison, Ind., through Jefferson, Ripley and Dearborn counties, to Cincinnati, O., a distance of about 60 miles. This is intended to be a double-track road, laid with 90-lb. rails, and is, Mr. Walkins states, to be built this spring.

The designer considered that a trolley system with central or terminal power station would not be satisfactory or economical for main line passenger and freight service, and he therefore designed the engine here described, plans for which have been prepared. It will resemble somewhat a baggage car, with a large locomotive cab added to the front end. Under the cab is the driving truck, with four 78-in. wheels, while under the rear end is a trailing truck with six 38-in. wheels. The engine will be 44 ft. 10½ ins. long, and will have a steel frame, with housings of wood and iron. Over the rear truck are the coal bunker and water tank; in the middle is a wagon-top locomotive boiler, and in the cab is a direct-connected Westinghouse engine, with two generators of 400 E. HP., one on each side. The driving truck will have two Westinghouse motors of 350 E. HP., direct connected with the four driving wheels, the power being transmitted to each wheel at 6 ins. from the edge of the rim. The motors are arranged to work together or separately. The Westinghouse-American outside-equalized air brake will be fitted to the driving wheels, and the equipment will include Trojan couplers, the Cory patent force-feed lubricator for bearings, the Leach sand-feed apparatus, Korting injectors, electric headlight, the Consolidated steam heating apparatus, and the latest type of Westinghouse electrical appliances, steam economizers, etc. The engine is designed to traverse curves of 300 ft. radius.

In the engineman's cab will be storage batteries (on each side), of sufficient capacity to move the locomotive to a sidetrack in case of emergency. There also will be the operating levers, switchboard, controllers, etc. On the trailing truck will be a motor of 200 E. HP. as a reserve for use in case of emergency, the motor being geared to one set of wheels, with a lever arrangement, by which the armature is thrown out of gear and remains idle when not in use, the wheels then running free. The controller and power gear are so arranged that when the main driving motors operate in connection with the motor of the rear truck, the speeds will be alike, so that they can be worked together when the engine is starting or is hauling a heavy train up a grade. Trials have already been made on the Nantasket Beach branch of the New York, New Haven & Hartford R. R., with a motor car built on this system. The general dimensions of the proposed engine for the new line above mentioned are given below, and a brief discussion of the general principle of the design will be found in our editorial columns.

Driving wheels, diam.	6 ft. 6 ins.
Truck " "	2 " 9 "
Length over frames	44 " 10⅜ "
Weight on driving wheels	145,375 lbs.
" " truck wheels	34,635 "
" total	180,010 "
Boiler—Type	Extended wagon top.
Diam. of barrel inside	6 ft. 4 ins.
Thickness of barrel plates	⅜ in.
Height from rail to center line	7 ft. 7 ins.
Working steam pressure	180 lbs.
Firebox	For bituminous coal.
Length inside	9 ft 0½ in.
Width inside	4 ft. 8½ ins.
Depth	5 ft. 0½ in.
Thickness of plates	5-16 and ⅜ "
Grate	Water tubes and bars.
Tubes—Material, iron; number	301
Length between tube plates	13 ft.
Heating Surface—Tubes	1,655 sq. ft.
Firebox	210 " "
Total	1,865 " "
Smokestack, height from rail to top	14 ft. 9 ins.
Capacity of tank	4,000 gallons.
Capacity of coal space	8 tons.
Generators, two, each of	400 E. H P.
Motors, " "	350 " "
" one of	200 " "

COLORS FOR NIGHT SIGNALS.*

It seems best to outline first the different arrangements now in use for giving information at night by means of signals. The system most generally adopted in this country, and which is standard upon nearly all of the most important trunk lines, employs the ordinary semaphore signal with single spectacles, and the following colors: Red for "danger," green for "caution," and white for "clear." An arrangement of lights has been made and is in use upon three roads in New England, which employs three lamps upon each post, and blinders are placed upon the semaphore blade and the up and down rod in such a way as to produce what might be termed semi-position indications; two horizontal white lights indicate a horizontal position of the arm, and two vertical lights an inclined or safety position.

Another arrangement consists of a double spectacle for

*Abstract of report of committee of the Railway Signaling Club; presented March 10, 1896.

the home signal, which is provided with a red and green glass, which in the danger position exhibits a red light, and in a clear position a green light. Upon the distant signal a double lamp is used, so that one flame illuminates two windows at about 9 in. centers placed horizontally. A blinder and a red glass are provided in the spectacle casting, so arranged as to give a caution indication by means of a red light horizontally beside a green light, and a clear indication by a green light only. This is known as Carter's arrangement, and it is used upon the Chicago & Northwestern Ry., it being the design of Mr. E. C. Carter, Principal Assistant Engineer of that road.

The following arrangement has been adopted upon another road: Red for "danger," green for "clear," and white for "caution." This has not been used to any great extent, but one road being known to have adopted it, and that a small one.

The system most used in England employs but two colors, namely, red for "danger" and green for "clear," there being no caution signal in that country as we understand and use the term here. The English distant signal gives the same indications as the home. It is not a stop signal and gives a cautionary indication merely by its being know to be a distant signal from its location. Recently, however, a necessity for a caution signal has apparently arisen in that country, and Mr. H. Raynar Wilson, signal superintendent of the Lancashire & Yorkshire Ry., a member of this club, writes regarding it as follows:

We have in this country on some of the lines, namely, London, Brighton & South Coast; London, Chatham & Dover; North London, and Lancashire & Yorkshire railways, what is known as a "calling-on arm." This arm is one of reduced size fixed below the home signal arm, and the interlocking is so arranged that when the top arm is "off" the calling-on arm is locked at "danger" and vice versa. The arm shows no light at all when at "danger," and when off gives a small green light. Our rules for working such signals are as follows:

"When the calling-on arm is lowered the home signal will be at danger, and vice versa.

No light will be exhibited at night when the calling-on arm is at danger, but when the arm is lowered a small green light will be visible.

Drivers must bring their trains to a stand when the home and calling-on arms are at danger, and when the line upon which the train will travel is blocked, but sufficiently clear to admit the train, the signalman will lower the calling-on arm, which will authorize the driver to draw slowly and cautiously forward, but only so far as the line is clear. When the home signal arm is lowered drivers may proceed forward.

Signalmen must not lower a calling-on arm until the approaching train has been brought to a standstill at it."

If you were to adopt such a signal, it would appear to me that would serve admirably as a caution signal, as a driver seeing the top arm at danger, and the small green light, would know that the line ahead was not clear throughout, and would proceed cautiously, while during the day the signal would be very distinct.

Attempts have been made to solve this question by the adoption of a position signal for night as well as day, in which by the light of a lamp, as reflected upon a mirrored surface of the semaphore arm, the arm itself would be illuminated and by its position, and in some cases by a change of color also, give the necessary information to the engine men. The two best known forms are the Koyle parabolic semaphore and the arrangement of Spicer & Schreuder, which employed a flat surface instead of the parabolic form.

Among the plans which have been proposed but not adopted are those which employ red for "danger," green for "clear" and a third color for "caution," and those which make use of the first two colors just mentioned for the home signals and for the distant signal indication employ more than one lamp and give the indications by arranging two lights vertically or horizontally in accordance with the position of the arm. It has also been suggested that the distant signal be discarded as such and its place be taken by a permanent sign in the form of a slow-board against which a lamp would reflect light at night for the purpose of calling the attention of the engineman. This would merely indicate the approach to an interlocking plant. In addition to these methods several patents have recently been taken out for illuminating a semaphore blade by means of a line of incandescent electric lamps receiving a current from "a convenient source." The list of suggested systems is much larger than this, but it is believed that the most prominent and best authenticated have been mentioned.

A suggestion has been made, though it has not been known to have been put into practical use, in which the red, green and white indications, giving respectively danger, caution and clear, shall be retained, but in the manufacture of glass used to give the red and green indications a wire netting shall be placed within the glass itself, whereby the danger of breakage is greatly reduced.

If the distant signal was not necessary, there would be no color problem for night signals, the red and green being admirably adapted to the giving of safety and danger indications, and in studying the question two points are to be considered: First, is what may be termed the common practice of using red for danger, green for caution, and white for clear, dangerous to such a degree as to require a change? Second, if the change is necessary, how shall the caution indication be given? The attempts to use illuminated blades do not seem to have attained results sufficiently satisfactory to warrant turning to them for relief, although they constitute what is theoretically an ideal signal. Before drawing a conclusion, it seems advisable to look over the systems in use and proposed, with a view of comparing them upon the basis of the real object to be sought, which comprises distinctiveness in indication, the principle of giving a danger indication in case of failure (which in this case would be a broken glass), clearness of indication at a distance in thick weather, consistency, practicability and reasonable cost.

In looking over the systems mentioned in the foregoing, the objection raised to the first mentioned system, which is in most general use, is that the breaking of a red or green glass may give a clear indication. The criticism of the system employing several lamps and giving caution and clear indications by means of lights arranged vertically and horizontally, is that the number of lights is confusing, and also, the cost is high both of installation and maintenance. The principal objection to the Chicago & Northwestern, or Mr. Carter's system, is that a general adoption of the plan would involve considerable expense. This arrangement is considered practical, efficient and safe, and it does not require more than one lamp per signal. It is no more inconsistent to show a red light in connection with a green light upon a single post for a caution indication, than to show a green and a red light vertically over each other upon one post at a route signal, one arm of which is clear. This signal is distinctive, the absence of a red or green glass would not indicate clear, it can be seen at a sufficient distance, and it might be advisable for a road commencing to equip with signaling to adopt this as a standard, but the cost of the double spectacles and the special lamp, while not great for an individual signal, would constitute an objection which, in the opinion of the committee, the advantages to be gained by the system are not likely to overcome to a sufficient degree to secure its adoption in place of existing systems.

By using white for a cautionary indication, a broken red glass might give a cautionary indication when a danger indication was intended. This is open therefore to the same objection as the first mentioned plan. The objection to the "calling-on signal" is that it would conflict with the present system of using route signals and also an extinguished lamp on a red signal would lead to great danger.

In the deliberations of the American Railway Association and the American Society of Railroad Superintendents, a great deal of attention has been paid to this subject of colored lights for signals. The former organization does not feel justified in recommending a change from the system employing white for a night signal, and it has endorsed, though not recommended, Mr. Carter's system. The superintendents' society is on record unanimously to the effect that there is not sufficient reason for discontinuing the use of white for a clear indication in American signal practice. It must be admitted that it is desirable to discard the white and to use green for "clear," but in view of the fact that to a very large extent, practical questions must govern, the committee deem it advisable at this time to make the following recommendation.

Inasmuch as no satisfactory third color has been found by which to indicate caution, and as it would be unwise under the circumstances to recommend any change from the present widely used system which would involve much expense and radical change of standards, and also as the present state of the art with regard to illuminated blades, does not warrant dependence upon the position signal, the committee believes that the best arrangement for the club to recommend at this time is that the present most generally used system be retained, namely: red for "danger;" green for "caution" and white for "clear," and that precautions be taken by thickening the colored glasses, or by embodying within them a netting of wire whereby the danger of breakage would be very nearly if not entirely overcome. (Wire nettings have been successfully placed against the ordinary glass in the present form of spectacle castings and with good effect.) There seems to be no system which so nearly as this meets the requirements as stated and against which fewer important objections can be raised. It is not considered an objection that some other white light might be mistaken for a clear signal, in view of the fact that experience has shown that trouble is not to be anticipated on this account. The committee has experimented, as has been already stated, and after going over the ground carefully, the conclusion has been reached that no other recommendation can be effective. It will require stronger arguments than any which have yet been brought up to bring about a radical change of system, and the best system for this club to endorse seems to the committee to be one which carries with it a possibility of general application.

A WIND VELOCITY OF 82 MILES PER HOUR was reached for one minute during the storm of March 4, in New York city. This is said to be the highest velocity on record at the New York station of the Weather Bureau. During four days of the storm the wind velocity ranged from 35 to 45 miles per hour. The aggregate wind record for the month of February at this station was 14,402 miles, an average of about 20.7 miles per hour.

A NEW TECHNICAL SCHOOL will probably soon be established in Hartford, Conn. Leading members of the Board of Trade are agitating the matter, a committee has been appointed, and a public meeting of citizens favoring the project is to be called. The industrial establishments of Hartford are growing rapidly, and their owners are complaining that men of technical training to fill positions in these establishments are scarce. It is probable that the proposed technical school will be a sort of an annex to Trinity College.

A DEEP-SEA SOUNDING of 5,155 fathoms, or 30,930 ft., is reported as having been made by the British warship "Penguin," between Tonga and New Zealand. The deepest previous sounding was that made by the U. S. warship "Tuscarora," off the northeast coast of Japan. This was 4,655 fathoms, or 27,930 ft.

A NATIONAL FORESTRY POLICY COMMISSION has been named by the National Academy of Sciences in response to a request from the Secretary of the Interior. Its members are: Prof. Chas. S. Sargent, director of the Arnold Arboretum, of Harvard; Mr. Alexander Agassiz; Gen. Henry L. Abbot, Engineer Corps, U. S. A.; Prof. William H. Brewer, of Yale University; Mr. Arnold Hague, of the U. S. Geological Survey, and Mr. Gifford Pinchot, arboriculturist. This commission is to report upon the disposal and preservation of forest lands; the prevention of fires and the extension of forest lands; the influence of forests upon climate, soil and water supply; the specific legislation necessary to remedy existing evils, etc.

SURVEYS FOR A PARK SYSTEM FOR INDIANAPOlis have been made and a map prepared for the park commissioners of that city. Mr. J. C. Olmstead has been consulted in the matter, and Mr. J. C. Power is reported as the engineer for the commissioners. About 995 acres, including drives and water surface, are included in the system shown by the map.

AN ALCATRAZ ASPHALT-CONCRETE RESERVOIR lining is to be put in for the Oakland Water Co. by J. S. Jackson, of San Francisco. The reservoir will be 25 ft. deep and have a capacity of 10,000,000 gallons. It will be almost wholly in excavation. The inner slope will be curved to a radius of 32 ft. Both the slopes and bottom will be lined. The excavation will be done by Mr. W. J. Schmidt. We are indebted to Mr. W. F. Boardman, a hydraulic engineer of 456 8th St., Oakland for the above information. Mr. Boardman states that Mr. Jackson lined the Linda Vista reservoir of the Oakland Water Co. with asphalt-concrete; that it "has given perfect satisfaction and is far superior to cement lining."

FEEDING CITY GARBAGE TO SWINE IN MASSAchusetts will probably be continued at least a year more, the Legislature having rejected the bill making this a penal offense, upon which editorial comment was made in our issue of March 5.

A SYSTEM OF ELECTRICAL SUBWAYS for Washington, D. C., is recommended by the District Commissioners in a report to the Senate District Committee of Congress. The recommendation was embodied in a report on a bill to incorporate the Columbia Telephone Co., a rival company with power to lay subway conduits. The report discusses at some length the general subject of franchises for the use of public streets, and presents a bill providing for leasing to a private company the right to put in electrical subways, the system to become the property of the district at the expiration of the franchise, the district meanwhile to have the use of the subways for its wires free of charge.

A MUNICIPAL ELECTRIC LIGHTING PLANT is proposed for Cleveland, and steps are being taken to secure the necessary legislation. Bonds to the amount of $1,500,000 are proposed, subject to approval by a popular vote. The price for incandescent commercial lighting is fixed at ½ ct. per lamp hour in the draft of the bill.

THE NEW DELAWARE RIVER BRIDGE, built by the Pennsylvania R. R. Co., at Bridesburg, Pa., is completed. Work was commenced on March 13, 1895; and the last pin was driven on Feb. 27, 1896. Three fixed spans of 540 ft. each and a draw-span, of 330 ft., cross the river, and on the Pennsylvania side there is an iron approach 2,200 ft. long, with another of 323 ft. on the New Jersey side. The total length of the iron work is 4,900 ft. The contractors for the masonry were Messrs. Drake, Stratton & Co.; and Messrs. A. & P. Roberts & Co. built the superstructure. The mid-piers are founded in 68 ft. of water, and they were sunk by the pneumatic process, with wooden caissons. This bridge will be used for running western trains to New Jersey seashore points, by way of the Connecting Railway, and for the transfer of freight formerly sent across the Trenton bridge and south from that point. Local trains will also be run across the river from the Broad St. Station, in Philadelphia, thus enabling passengers to avoid the ferries and delay by ice.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of standing advertisements must be in hand on Monday after noon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The city of New York is to be congratulated that its projected rapid transit railway enterprise has received the approval of the able commission appointed by the Supreme Court to pass upon the question whether it is for the public interest on the whole that the plans which the Rapid Transit Commission has matured shall be carried out. The great enterprise has now only one further gauntlet to run before it is carried into execution; that is, the submission to the Supreme Court of the question whether the Rapid Transit act is in harmony with the New York Constitution. The opponents of the enterprise allege that certain features of the act are unconstitutional, and if the Supreme Court supports their view, further long delays may interfere with the carrying out of the project. If, on the other hand, the Supreme Court shall sustain the act, there appears to be no reason why the commission should not be in a position to call for bids for the construction and operation of the road by August or September.

The proposal that the United States shall pay a St. Louis syndicate the sum of one million dollars anually for 20 years for maintaining a navigable channel 6 ft. in depth from St. Louis to Cairo, and 7 ft. in depth from Cairo to Vicksburg, was ably discussed in our last issue by Messrs. Ockerson and Johnson; but it appears to us that there are aspects of the question which deserve some further consideration. The letters published in our last issue were chiefly devoted to the question whether the work should be done by the St. Louis syndicate under a 20-year contract, or by the Mississippi River Commission. It is by no means clear to us that the work should be undertaken at all, if its cost is to reach the enormous sum of $1,000,000 per annum. We have looked carefully through the report of the Congressional committee bearing upon the bill in a search for some fair presentation of the saving in transportation charges which will accrue from this proposed deepening of the low water channel, but are unable to find it. There is, indeed, a statement by Mr. Samuel (one of the parties who is asking for this contract), in which, after various arithmetical gymnastics, he winds up with the conclusion that "the benefit would exceed $50,000,000 annually." We cannot follow Mr. Samuel in the mathematical flights by which he reaches this astonishing saving, and we may merely remark that if his estimates of the cost of the channel improvement which he proposes to undertake are made in a similar manner, it is highly probable that the United States can carry out the work itself for a trifle of the price which he asks.

We do find, however, in Mr. Samuel's argument, some statistics from which it ought to be possible to form an approximate idea as to the limits of the gains which the proposed deepening of the channel would bring about. We find in the first place a statement of the stages of water in the Mississippi from July 1 to Jan. 1 for the years 1891 to 1895. According to this showing the months of September, October, November and December are practically the only ones in which the river ever has less than 6 ft. of water between St. Louis and Cairo. The period during these four months when the water is below the above stage varies in different years, but averages between two and three months. In the very dry season of 1895 there was 7 ft. of water between St. Louis and Cairo up to Sept. 15; 6 ft. to Oct. 1; 4 ft. during October; 3 ft. from Dec. 1 to 20, when a great rise came, and only during November was navigation entirely stopped. This, by the way, had not occurred before at all during the five years recorded in the table.

It appears, then, that navigation from St. Louis to Cairo has been entirely stopped by low water only one month during the past five years, and that during some 14 months more in that time boats went on from 3 to 5½ ft., or an average of about 5 ft., which would have had 6 ft. had Mr. Samuel's proposed improvement been in progress.

The question is, then, is an average increase in depth of 1 ft. in the channel from St. Louis to Vicksburg during three months in the year worth $1,000,000 in cash? Is the volume of Mississippi River traffic from St. Louis southward which may reasonably be expected to move during these three months so great in amount that a foot deeper lading of the boats will save a million dollars or more in freight charges? In 1895 the total traffic on the Mississippi, between St. Louis and New Orleans, was a little over half a million tons. In the past 18 years it has exceeded a million tons in only two years. What part of this traffic is carried in the low-water months we do not know, but if we estimate that one-fourth goes in the three low-water months, it is evident that the United Staes would be paying from $4 to $8 per ton to secure lower freight rates on this portion of the traffic if it were to accept the proposition of the St. Louis syndicate.

There is another aspect of this matter to which we may devote a word. Every one knows the enormous reductions in the cost of rail freights which the past 20 years have seen. Is it not likely that the next 20 years will see further great reductions? And if this is so, how could it be wise for the United States to bind itself to a continuing payment for 20 years to come, when future changes may make such an expenditure of little use? The high-water rate on bulk freights from St. Louis to New Orleans is 1.3 mills per ton-mile; but as we stated in our issue of Oct. 31, the New York Central R. R. has carried grain at a rate as low as 2 mills per ton-mile, and has made a profit on the business. We venture to say that if the United States will agree to pay any railway company operating between St. Louis and New Orleans a million dollars a year for 20 years, it will be very glad to agree to carry bulk freights between those points at as low rates as the river steamers have ever made with the channel in its best condition.

The Heilmann locomotive, a French invention which received a great amount of publicity a year or more ago, has been briefly described as a complete electric generating station on wheels. On another page of this issue we publish a short account of a locomotive embodying similar ideas, which has been designed by an American engineer, and we are informed is to be built to run on a new railway in Ohio. We are sorry that the French are not to have a monopoly of this idea. The plan of combining in a single machine a boiler, engine, dynamo, storage battery and electric motor with the numerous operating and controlling devices which each require, and all for the purpose of propelling a car along a railway track, is one which harmonizes much better with the French mechanic's penchant for complication than with the American practice of choosing the simplest and most direct means of reaching a desired end.

Lest the above note should be misunderstood, we will add that we know of no reason why Mr. Walkin's locomotive, if it is actually built, should not run, and perhaps run as fast and haul as heavy a train, or perhaps heavier, in proportion to its weight than a steam locomotive; it may even be found possible to so manipulate figures as to make an apparent saving by its use. That remarkable feat was performed by the promoters of the Heilmann locomotive, and could, we doubt not, be equally well done here. But no matter how fast the locomotive may run or how skillfully its promoters may present their estimates, the fact will remain that it is a mechanical absurdity to develop mechanical power on a locomotive and then proceed first to convert it into electric current and next to convert that current back into mechanical power in order to apply it to the driving wheels.

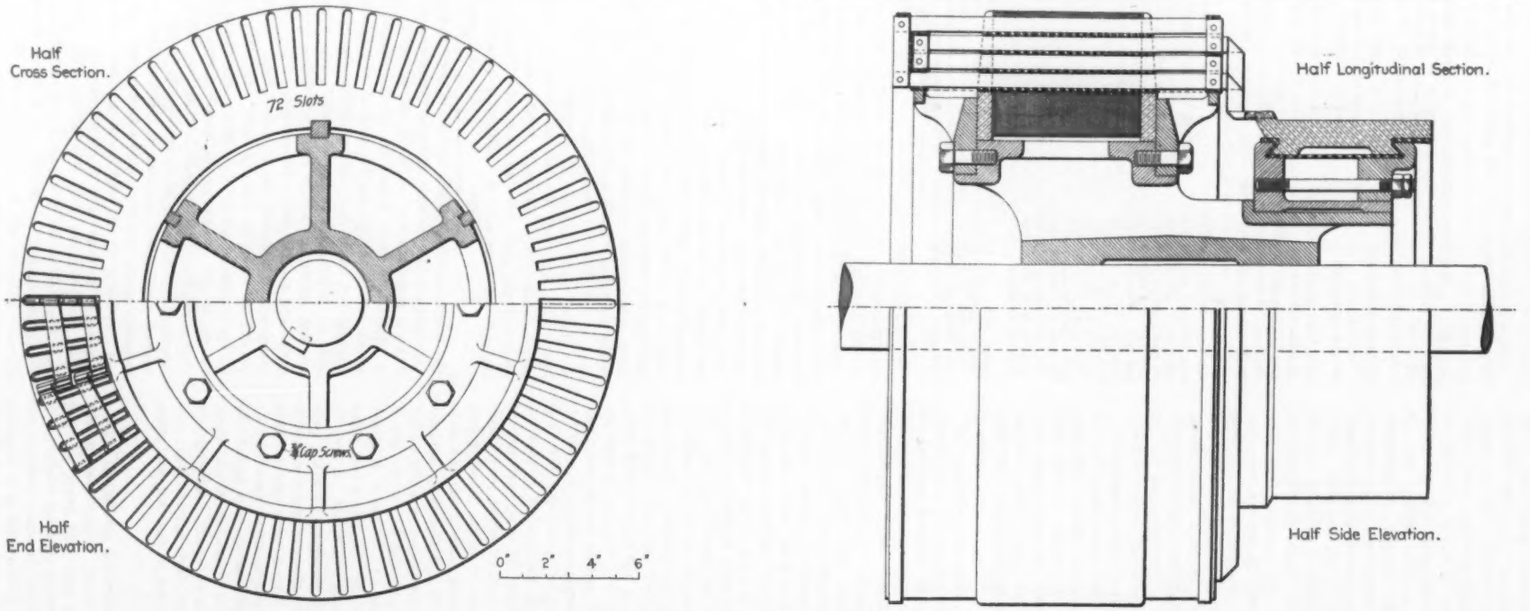
We have been led to explain our criticism thus fully because a correspondent recently took us to task for a very brief remark respecting the Holman locomotive in our issue of Dec. 5. This machine, which was built last summer, and was run experimentally upon the West Jersey R. R. for a short time, has its drivers resting on truck wheels, and the traction is transmitted through them to the rail. Our correspondent informed us that it ran successfully and attained high speed; why then did we refer to it as if it were not a valuable improvement?

Hundreds of people of moderate means in Minneapolis (the home of the inventor) are investing in the stock of the company formed to develop the invention, on the strength of last summer's tests. Our unfavorable comment, therefore, he considered, might be an injustice to a meritorious improvement.

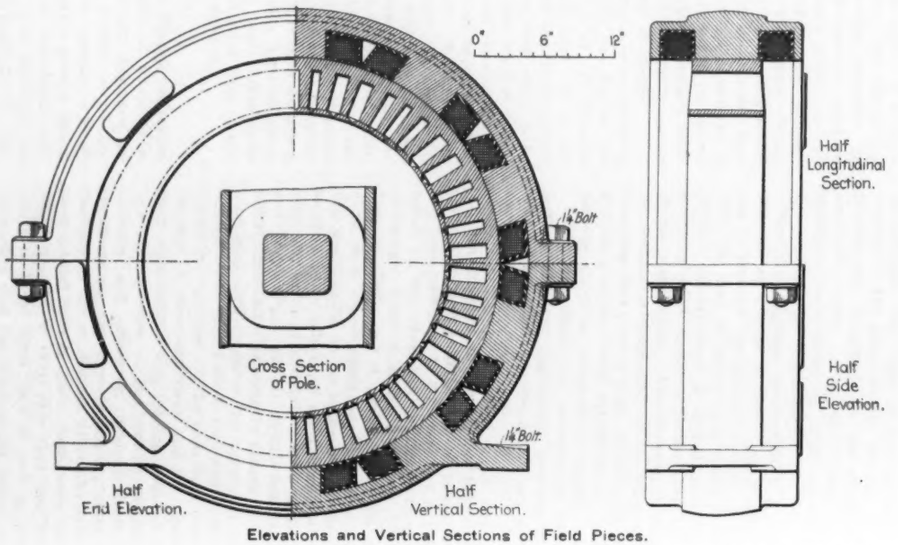
Now the Holman locomotive is a very good example of a class of inventions which are very apt to mislead the general public. The general principle may be safely laid down that no important improvement in any department of engineering work is ever effected save by the use of adequate means. The Holman locomotive, or the Heilmann locomotive, or the Walkins locomotive may run ever so fast, or pull ever so heavy a train, and yet it will not follow at all that they embody anything whatever of merit.

Inventions which are designed to remedy defects in ordinary engineering practice that exist only in imagination never attain any permanent success.

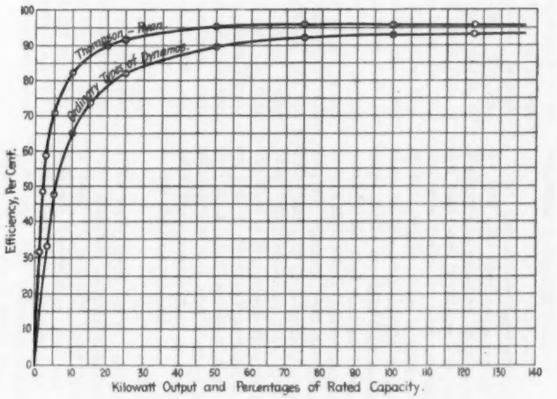
A bill intended to provide for improvement in the design and construction of public buildings has been presented to Congress and is now in the hands of the Committe on Public Grounds and Buildings. This is House Bill No. 1470, dated Dec. 12, 1895, and it provides for the appointment of a Commission on Public Architecture; this commission to be composed of three architects and two officers of the United States Army, who are to have general control of the design and construction of all public buildings. This bill is essentially wanting in failing to include at least one civil engineer, by name, in the commission. The use of steel, iron and fireproof materials in buildings of the type here referred to, the size of these buildings and the character of their construction and loading demand the service of engineers of the highest degree of experience and efficiency. Though some leading architects are also experienced engineers, the two professions are so distinct at the present day in their special lines of study, experience and application that it is very rare that one individual excels in both. This fact is now so commonly recognized that the engineering design of an important building is established as a separate profession, and the best architects confine themselves to the general design and decoration, and leave to these engineering experts all questions of detailed proportion and arrangement of the skeleton



Elevations and Vertical Sections of Armature and Commutator.



Elevations and Vertical Sections of Field Pieces.



Efficiency Curve of 100 K-W Thompson-Ryan Dynamo Compared with Curve from 100 K-W Dynamo of Ordinary Type.

THE THOMPSON-RYAN DYNAMO.

Designed by Milton E. Thompson, and Prof. Harris J. Ryan, Assoc. M. Inst. Elec. E. Made by the J. B. McEwen Mfg. Co., Ridgway, Pa.

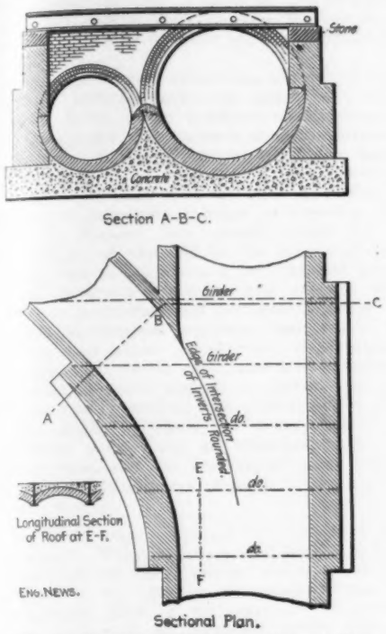


Fig. 1. Suggestion for Intersection of Two Circular Brick Sewers.
By E. H. Bowser, Louisville, Ky.

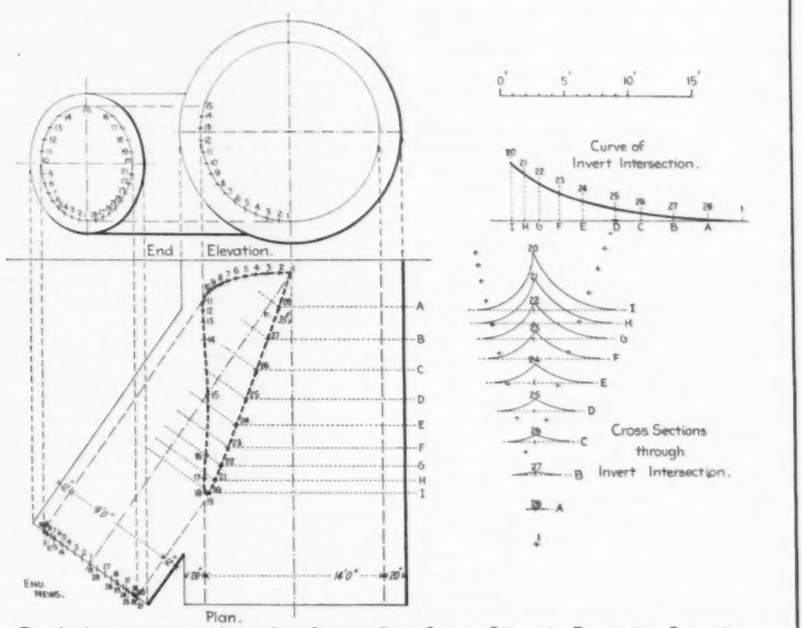


Fig. 2. Intersection of 14 and 9-ft. Circular Brick Sewers Solved by Descriptive Geometry.
By Dean Clark, Cornell University.

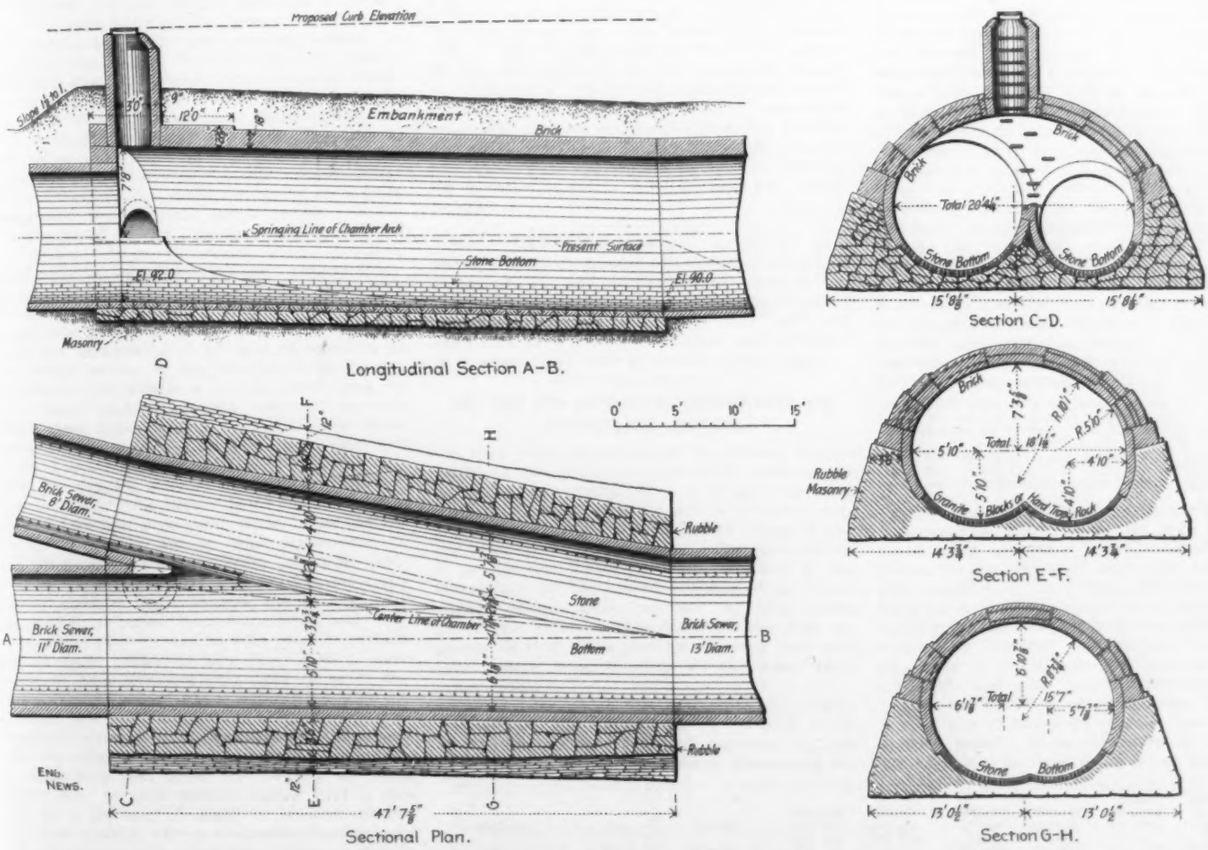
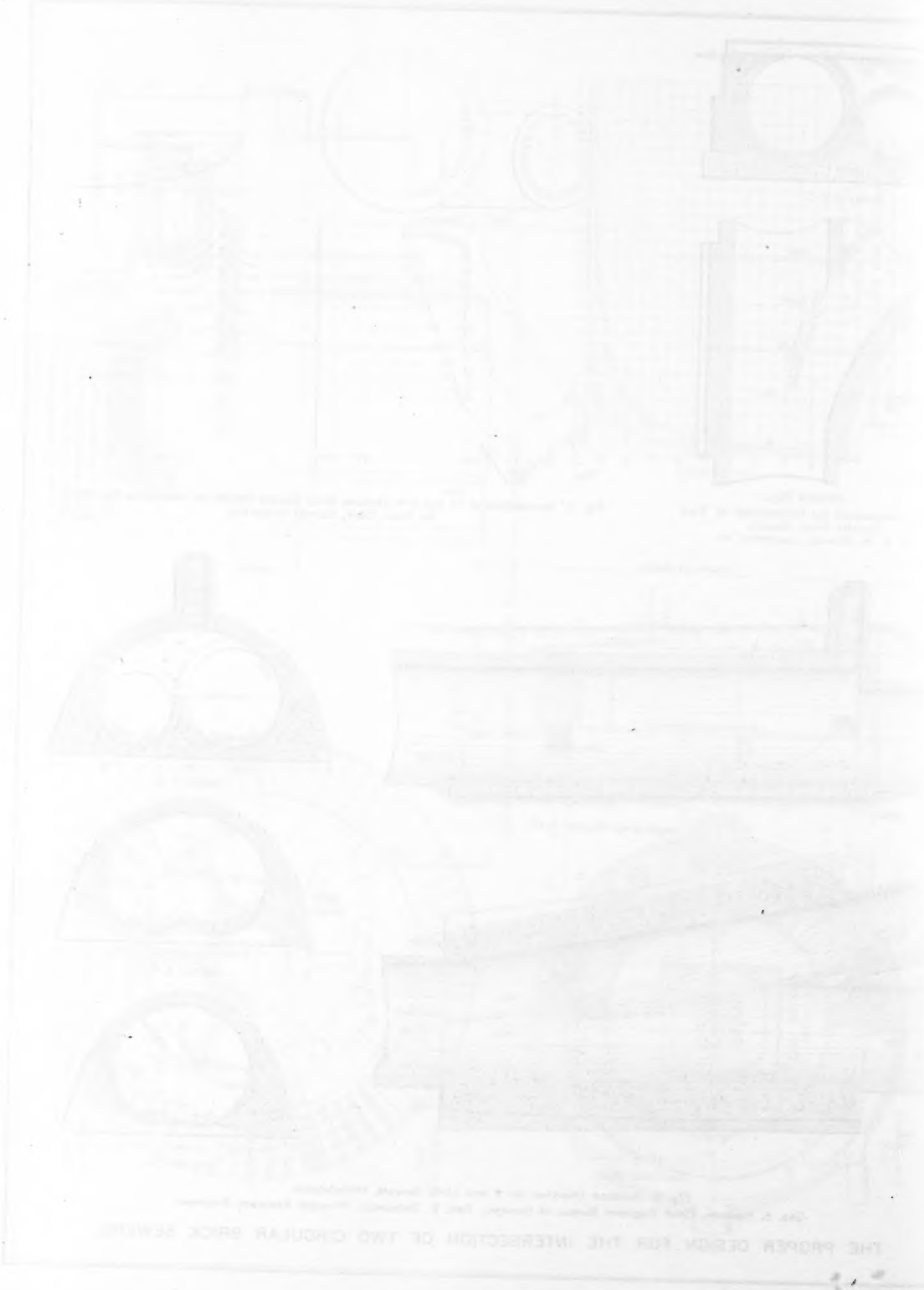


Fig. 3. Junction Chamber for 8 and 11-ft. Sewers, Philadelphia.
Geo. S. Webster, Chief Engineer Bureau of Surveys; Geo. E. Datesman, Principal Assistant Engineer.

THE PROPER DESIGN FOR THE INTERSECTION OF TWO CIRCULAR BRICK SEWERS.



of the building, and the stability of foundations and loading of varying foundation soils. This is being done in the erection of the Episcopal Cathedral in New York, the new Waldorf Hotel and in a number of other important structures in this city.

Judging from past experience, and failure from lack of proper engineering supervision in a number of our public buildings, the presence of an experienced civil engineer upon the proposed commission is not only eminently proper, but it is for the best interests of our Treasury Department, which pays the bills. The Western Society of Engineers, through its President, Mr. John F. Wallace, has already asked for an amendment of the bill on the lines here suggested, and the members of the engineering profession everywhere will do well to exert their influence to further this amendment. It is not a mere professional sentiment that is here involved. Our public architecture is notoriously deficient in aesthetic merit, and a commision of the kind proposed may do an exceedingly useful work in controlling future construction. But in the public buildings now being erected engineering plays quite as important a part as architecture, and the commission must contain an engineering expert to properly fulfil the duties required of it.

Our last issue contained a letter from Mr. Charles D. Walcott, Director of the U. S. Geological Survey, very plainly setting forth his position on the question of monumenting the topographic work of that survey. In another letter written to the Secretary of the Interior, recommending the proposed amendments to the bill now before Congress, Mr. Walcott says that the maps of the survey would be enhanced in value fully 100 per cent. if permanent records were left upon the ground, showing the positions of triangulation points and township corners. He estimates the cost of the necessary extra work, including the monuments themselves, as ranging from $1.00 to $1.50 per square mile; and he says that while the placing of these monuments will decrease by about one-fifth the general amount of work done, on a present basis of appropriations, he believes that the greater utility and accuracy of the maps will much more than compensate for the slight loss in output.

It is pointed out by Director Walcott that, for the present, these elevations above sea-level could only be established to the "nearest foot." No lines of exact levels yet exist west of the 97th meridian, except near the Pacific coast, and it would take several years to run them. He proposes the establishment of base monuments at convenient points in the interior, with an approximate determination of sea level, and to these monuments he would refer all surveys. When exact lines of level are run later to these bases, the true level can be placed upon them and all local levels referred to them.

The topographic work of the Geological Survey, as has already been stated, is an outgrowth of a smaller and less important work. Just as the British Ordnance Survey was commenced in 1791 for purposes purely military, and later grew into the present splendid organization, for topographic work, so the Geological Survey began its map making to record its geologic work, and these topographic surveys are now its most important field of duty. What is now planned is a topographical map intended eventually to cover the whole United States. About one-fifth only of the territory has been mapped thus far, and on the Director's estimate of not less than $10 per square miles for work of the character demanded, to map the remaining four-fifths will require at least $25,000,000. It goes without saying that if this work is to be done it ought to be done in the very best manner, and so accurately that no part of it will ever require repetition. Congress should appreciate the true scope and importance of this survey. The work demands the highest quality of scientific ability from everyone engaged in it, from the Director at the head to the topographers in the field. It is an unfortunate fact that in the past influence has had too much, and merit and ability too little, to do with filling the positions in the Geological Survey work. Congressmen and other influential men have been prone to regard this survey as a good place in which to get positions for sons and nephews. Complaints of errors in the work done by the survey have not been infrequent; and how much of this trouble is due to inexperience in surveyors can be better guessed at than measured. What is past is past and cannot be remedied. But if the Bureau is really to go on and carry out a topographic survey of the whole country, it should be definitely understood that past methods should be definitely and permanently abandoned.

In the attainment of this end, monumenting of the work done is a first and very important essential. Under the present methods no means exists of checking upon the ground the work of those engaged in the surveys. Figures may be safely put upon the map, and, except in the case of gross blunders in elevation and location, this record must pass unchallenged, for there is no certain way of identifying map points on the ground. But things are different if the placing of marked monuments is required. Director Walcott himself admits that more careful and accurate work is demanded as a preliminary, to such monumenting, and he submits estimates of this extra cost. The progress of the general work may be slower by reason of this exact work; but the more reliable and useful results, in surveys and maps, will far more than compensate. To go ahead upon the hasty and admittedly less reliable methods of the past would be almost criminal under the present development of our topographic survey; and that reform is needed is well appreciated by the Director of the Geological Survey himself and by the Secretary of the Interior.

It is now time for Congress to act. If the representatives of the people fail to recognize the full needs of this survey, by a refusal of adequate appropriations, or by permitting a continuance of past faulty methods, they must shoulder the responsibility for the waste and misuse of public funds. The people imperatively demand the best and most reliable and useful topographic maps that modern engineering skill can provide, and if the Geological Survey undertakes to furnish them, it should be held to strict account for the scientific accuracy of its methods and the reliability of its results.

The credit for the ordinance to prevent electrolysis, recently passed by the city council of Richmond, Va., and published in our issue of Feb. 27, is due to Mr. Chas. E. Bolling, Superintendent of the water-works. This fact was not known by us when the ordinance was published or it would have been so stated at that time.

THE SIZE AND CAPACITY OF FREIGHT CARS FOR INTERCHANGE SERVICE.

A very large proportion of the railway freight traffic of this country belongs to the class known as interchange traffic; that is to say, the cars travel over lines owned by several different railway companies in the journey from their starting point to their destination. For this reason it is essential for the prompt handling of the freight and for the smooth working of the interchange system that the cars for such traffic should be within certain limits of size and capacity, so that roads sending out their own cars may receive approximately similar cars from other roads.

The box car which now represents the modern standard of this class of rolling stock is about 34 ft. long, and has a freight-carrying capacity of 60,000 lbs., the cross-sectional dimensions being such as to be within the clearance limits of structures on a large majority of railways, so that such a car can be used for service between any two points in the United States. Within the past few years, however, cars of much greater cross-sectional dimensions have been built for carrying bulky light freight, and this practice has been mainly stimulated by the traffic departments in order to please shippers, since under the official classification of freight, minimum carload weights are established for freight of this kind, regardless of the size or capacity of the car. Consequently the shippers of this class of freight prefer the larger cars, and will (other things being equal) be more likely to patronize the road which furnishes the large cars. Similarly, some roads have introduced cars of very much greater weight-carrying capacity for heavy freight, designed for 70,000 or even 80,000 lbs. of coal, ore, grain, etc., which are usually fully loaded in one direction at least. These cars may be but little larger than those for normal loads. If such large and heavy cars were designed especially for, and run only upon, the "home" or owning roads, there could be no objection to their use, but when they are put in service for interchange traffic they are naturally and reasonably objected to by roads which use only cars of standard dimensions and weight, and whose tracks and structures are perhaps not suited for economically and safely handling such excessively heavy cars. On the other hand, some roads owning light cars of small capacity put them in interchange service, although they are not strong enough for efficient use in such traffic, and are of such small capacity that receiving roads as well as shippers strongly object to them. In this connection it may be noted that shippers are apt to consider that if large cars are furnished at one time and small cars at another, the railway or the freight agent is doing this purposely and for personal reasons, and hence arises a considerable amount of unnecessary friction between the railway company and its patrons, especially in cases where there is competition between two or more lines for a certain shipper's business.

The question of the limiting capacity for cars for interchange service has been much discussed since this particular kind of trouble has been experienced, and the New York Railroad Club appointed a special committee to consider the "Large Car" question. The report of this committee (of which an abstract is given in another column) was presented at the February meeting of the club, and is a very full and comprehensive review of the entire question. The discussion thereon resulted in the adoption of the following resolution, which seems to provide a satisfactory solution of the problem from all points of view:

Resolved: That it is the sense of the New York Railroad Club on the question of large capacity cars for general interchange service, that box and stock cars shall not be built to exceed a capacity of 60,000 lbs., and that this club earnestly recommends to the traffic associations that in making their rates on light, bulky freight such rates shall be based on the cubic capacity of the car.

As to the size of the large cars, the railways will probably haul the largest cars that come within their clearance limits, contenting themselves, for the present at least, with some protest and considerable grumbling. But very large cars built for interchange traffic are quite likely to be billed for some point on or beyond a road whose tunnels or overhead bridges have too small a clearance to admit these cars, and then the cars are held, and after much correspondence and friction the freight is either transferred to cars of normal size or the large cars are sent round by another route. As to the carrying capacity of the cars, if a full load could be assured for each

Railway.	Car.	Traffic.	Length of body. Ft.	Length of body. In.	Width of body. Ft.	Width of body. In.	Weight of car. Lbs.	Weight of load. Lbs.	Total loaded weight. Lbs.	Percentage of total weight. Car. %	Percentage of total weight. Load. %
No. Pac.	Box.	Grain.	41	0	8	6	32,000	70,000	102,000	31.37	68.63
N. Y. Cen	"	Freight.	34	0	8	10	26,000	60,000	86,000	30.21	69.79
Penna.	"	"	36	0	..	..	30,000	60,000	90,000	33.34	66.66
C., C., C. & St. L.	"	"	34	0	8	3	33,500	60,000	93,500	35.83	64.17
So. Pac.	"	"	35	0	..	..	27,000	50,000	77,000	35.06	64.94
C., B. & Q.	"	Furniture.	39	5½	8	5½	30,000	50,000	80,000	37.50	62.50
Penns. Lines.	Gondola.	Ore, coal.	28	0	8	11	35,500	70,000	105,000	33.34	66.66
P. & R.	"	....	34	0	..	..	22,800	60,000	82,800	27 54	72.46
C., B. & Q.	"	Ore, coal.	28	0	8	6	24,000	60,000	84,000	28.57	71.43
N. & W.	"	"	26	0	8	0	27,900	60,000	87,900	31.75	68.25
D. & I. R.	"	Ore.	21	2	8	0	24,400	53,760	78,100	31.17	68.83
C., R. I. & P.	"	Coal.	33	10	8	6	26,600	50,000	76,600	34.73	65.27

trip it would certainly effect an economy to increase their capacity, thus reducing the number of cars, axles, journals, brake gears, couplers, etc., to be attended to, and reducing the proportion of dead load to total train load. This increase in weight may be carried up to the limit of weight permitted to be imposed on the journals. If, however, the average load is considerably below the rated capacity, the increase in capacity may serve only to increase the proportion of dead load to total load, giving lower rates to shippers and an increase in operating expenses. The present maximum capacity of cars in regular service is 60,000 lbs., but the Northern Pacific R. R. has a number of box cars (for grain) of 70,000 lbs. capacity, while a few roads have ore and coal cars of 80,000 lbs. capacity. The accompanying table shows the general dimensions, weight and proportions of live and dead load of several standard large capacity freight cars now in general service:

Economy in transportation is of course increased by a reduction in the number of cars and trains for a given quantity or weight of freight, within certain limits, and this may be effected by increasing the car capacity so as to increase the proportion of live load to dead load. Two modifying conditions to this practice, however, are the maintenance expenses of the track and of the rolling stock. If the dead load is reduced to too small a percentage of the total load the cost of maintenance of the car will be increased, while if the total load is beyond the maximum which the track can economically sustain, the cost of maintenance of way will be increased. With all these considerations taken into account and provided for, there still remains the further very important consideration that the full economy in operation will only be reached if the cars are fully loaded in each direction of haul. This is a condition of things which rarely obtains, and in fact it is very generally the case (as with ore and coal cars) that where cars are regularly loaded full in one direction they have to return empty, while in other cases there is an approximately full load in one direction and a light load in the other direction (as with grain, refrigerator and fast freight or private freight line cars). The carrying capacity to be adopted becomes then largely a question of what we may call the "average maximum" actual car load, and if this does not exceed 60,000 lbs. it would hardly be advisable to adopt 70,000-lb. cars for general service. This view of the average maximum car load is probably what influenced the second committee of the New York Railroad Club in presenting its resolution (already quoted above) recommending 60,000 lbs. as the limiting capacity for regular interchange service, thus putting cars of greater capacity on the list of special cars for special service, and ranking them with the special cars for carrying guns, cables and other exceptionally heavy loads.

But if railways are to put a maximum limit to the car capacity, so as not to average a heavy haul of dead load, it is equally important to put a minimum limit, so that roads owning cars of standard size may not be subjected to the inconvenience and injustice of receiving in return small light cars of such low capacity and light weight as to be objectionable to shippers and dangerous to traffic if mixed in with heavier cars. It is a well-known fact that some railways owning small cars are in the habit of sending them out for interchange traffic, retaining the large cars of other roads for their own local traffic, thus practically exchanging small cars for large without any expense to themselves, since the small cars may not get back to the "home" road for a long while. For this reason it has been proposed to exclude from regular interchange service cars of more than 60,000 lbs. and less than 40,000 lbs. capacity.

Another question to be considered is the relation of the carloads to maintenance of way. As pointed out in our issue of June 20, 1895, in connection with the suggestion made by the President of the Master Car Builders' Association, that the association should prepare plans and specifications for 80,000-lb. cars, the tendency has always been to increase the weight of train loads and wheel loads without regard to the track and structures, and then, after considerable expense and trouble in maintenance, to eventually strengthen the track and structures to sustain the increased loads. While many roads are now using 75-lb. and 80-lb. rails quite extensively (and even 90-lb. and 100-lb. rails), and maintain an excellent track, the fact remains that on very many roads the track is now far below the condition necessary for economical and safe operation of the present rolling stock. It is not the total distributed train load which affects the track, so much as the intensity and concentration of wheel loads, and even if the loads on the car wheels equalled those on the engine wheels, their destructive force would still be much less, owing to the effect of slipping and bad counterbalancing, and to the heavy strains imposed upon the rails by the driving wheels when pulling hard with a heavy load. Fully loaded cars of 70,000 and 80,000 lbs. capacity would have wheel loads of about 13,000 lbs., while fully loaded cars of 40,000 to 60,000 lbs. capacity have loads of 7,500 to 11,000 lbs. per wheel. These however, are maximum loads, and are distributed over a car wheelbase of 24 to 37 ft., and a truck wheelbase of 5 to 6 ft. Heavy freight engines, however, have driving wheel loads of 12,000 to 16,500 lbs. per wheel, with three or four of such loads concentrated on a wheelbase or rail length of 12 to 18 ft. For structures, of course, the total train load is a governing consideration, but even here heavier wheel loads without an increase in the load per foot of train will increase the destructive effect of the traffic upon the structure. An article on the relation of track and track work to the weight of locomotives will be found in our issue of July 25, 1895.

LETTERS TO THE EDITOR.

Growth of Population and Railway Traffic in the United States in 25 Years.

Sir: I send you herewith a diagram showing the growth in the population and in the railway mileage and earnings of the United States for the past 25 years,

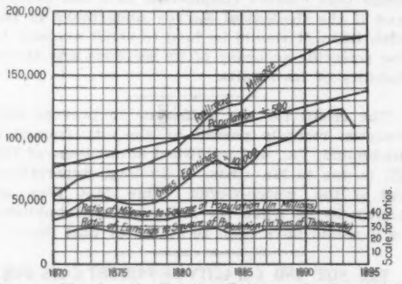


Diagram Showing the Relation Between the Population and the Mileage and Earnings of the Railways of the United States from 1870 to 1895.

and the relation of the former to the latter, which strikingly illustrates the fact enunciated by the late A. M. Wellington that railway traffic increases as the square of the population served; the quotients of the mileage and earnings by the square of the population being nearly uniform. Yours truly,

John Marston, Jr.

Bullitt Building, Philadelphia, Pa., Feb. 20, 1896.

Do the Examiners Need Examination?

Sir: In your issue of Feb. 13, under the questions of the New York State Civil Service examinations, I notice an inconsistency in the data given in one of the problems. In Form B, question 2, a Warren girder, composed of equilateral triangles, is given with the following dimensions: 10 ft. deep, span 80 ft., 8 equal panels. The length of one panel would then be 10 ft., and the triangles composing the bridge would have for a base 10 ft., and an altitude of 10 ft.; hence they could not be equilateral. I would like to ask if this was not an oversight on the part of the examiners in drawing up the paper?

Yours truly,

John H. Gregory.

No. 3 Mt. Vernon St., Boston, Mass., Feb. 15, 1896.

(We referred the above letter to the Commission, and their reply states that the above error was discovered after the papers were printed and that the candidates were all informed that the triangles were equilateral and not 10 ft. in height prior to the examination.—Ed.)

The Proper Length for Sewer Pipe—2 or 3 Ft.

Sir: The question raised in your issue of Feb. 20 by Mr. B. E. Briggs, concerning the best length for sewer pipes, has engaged the attention of sewer engineers for several years past. The sewer pipe makers objected to furnishing pipe in lengths more than 2 ft. long, owing to the loss of 3 ft. of pipe in case of breakage in transit; but at present several firms are furnishing 3-ft. lengths up to 20 ins. in diameter. Greater care in loading has reduced the breakage to a very small amount.

Regarding the greater liability of getting crooked pipe mentioned by Mr. Brooks: I have found for several years past that the pipe rejected under a specification throwing out pipes that deviated from a straight line more than ½ in. in 3 ft. would not amount to more than 0.1%. I consider that the lesser number of joints obtained by using 3-ft. lengths of pipe is a great advantage, especially in wet ground. Yours truly,

Brunswick, Ga., Feb. 24, 1896. Wm. B. Landreth.

The Nordberg Pumping Engine at Kensington, Pa.

Sir: We were much interested in your last week's issue, which contained an account of the Nordberg pump at Kensington, Pa. We were the engineers for the Burrell Water Co., owning and operating the works at Kensington, Pa., and it was under the general specifications written by us that Messrs. Nordberg and others bid for these pumps, each individual bidder furnishing the detail specifications. We take pleasure in saying that the Nordberg Mfg. Co. furnished work fully up to their requirements, and the pumps are working under something like 150 lbs. pressure, smoothly in all respects.

We might say, however, that while the article referred to speaks of two pumps furnished by the Nordberg Company; only one has been put in place. There is no reason why a second pump should be furnished at present, as the first pump is more than equal for any requirements of the work.

The original specifications required that "the bidder shall state distinctly what he will guarantee for the economical working of the pump, and upon what basis this economy test is to be figured." The idea of this was to allow the bidders to specify their own test, as each would know his ability to perform it. Said specifications also provided that "after the pump has been in use three months, a test shall be made under the conditions of the gaurantee for economy, by the engineer of the Burrell Water Co. and by a representative of the contractor." Up to the present time no test has been made by the engineer of the Water Co. and contractor jointly. The original provision of the builder was:

We guarantee the engine to perform a duty of 110 million foot-pounds for each 1,000 lbs. feed water evaporated into steam from and at 212°, steam pressure during the test to be 130 lbs. per sq. in., water pressure 155 lbs. per sq. in., and pump speed 180 ft. per minute.

We believe the article referred to to be correct, except in the statement that there are two pumps in the place instead of one, and that a duty test of 125 million foot-pounds has been obtained.

Respectfully yours,

James H. Harlow & Co.

Pittsburg, Pa., March 2, 1896.

The Ashtabula Bridge Disaster.

Sir: Will you please tell in your paper something of the cause of the Ashtabula bridge accident.

S. L. Kennedy.

Kilburn, Wis., Feb. 26, 1896.

(The Ashtabula bridge, on the Lake Shore & Michigan Southern Ry., collapsed under a passenger train, Dec. 29, 1876, the falling of the train and the burning of the wreck causing the loss of nearly 30 lives. This terrible accident marked an epoch in the history of the introduction of iron bridges. The bridge was an iron double-track deck structure, with a span of 156 ft., the two trusses being 20 ft. deep, divided into 14 panels. It was of the Howe truss type, which is a type not adapted for iron bridges, and during the early days of iron bridges was mainly used by builders accustomed to wooden bridges, and entirely ignorant as to the properties of iron used as structural material. Some great mistakes were made in the design, so that when the removal of the falseworks was commenced the bridge began to settle in such a way as to indicate that it would fall by its own weight. It was therefore shored up, and extensive changes were made, the bridge being finally opened for traffic in 1865. An expert investigation showed that the material was not of good quality, though the fact that a bridge of such design had stood so long under the severe strains to which it was daily subjected was an evidence of the value of a wrought-iron bridge. Many of the members were unnecessarily heavy, while the top chord (which did not break) was too light. The cause

was primarily due to faulty design, and the first failure was the breaking of lugs on the cast-iron angle blocks against which the braces rested. These lugs transmitted the strains from the braces to the top chord. The bridge was described and its failure discussed in several numbers of our volume of 1877.—Ed.)

Wreck of the Draw of the Bridge at Rock Island, Ill.; C. R. I. & P. Ry.

Sir: I enclose herewith clippings in regard to the falling of one arm of the new draw span of the bridge across the Mississippi, between Rock Island, Ill., and Davenport, Ia., now in course of construction. From the city of Rock Island to the "government island," on which the U. S. Arsenal is located, the highway and railway traffic have separate bridges, while the bridge across the channel, consisting of five spans of about 300 ft. each, and one draw span of about 360 ft., Pratt trusses of the Phoenix pattern, carried the highway traffic on the lower deck and a single railway track on the upper deck. It is this main bridge which is being rebuilt by the United States government and the Chicago, Rock Island & Pacific Ry., so as to carry two tracks.

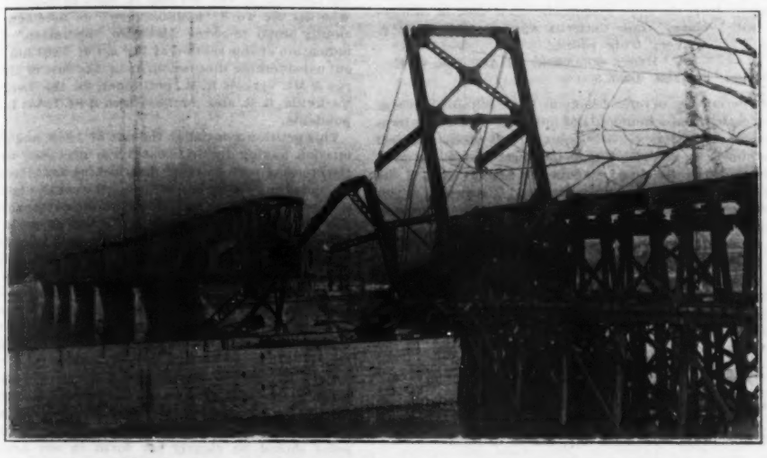
The photograph was taken from the lower end of the island, showing the wrecked draw span, with the five fixed spans beyond, and also the temporary trestle from the long stone draw pier to the shore of the island.

The intention now is to erect a temporary lifting bridge across the opening where the wreck occurred, and to build the permanent span on the long stone draw pier.

Yours respectfully,
J. W. Woermann, Assoc. M. Am. Soc. C. E.,
Res. Engr.; Ill. & Miss. Canal.

Milan, Ill., March 1, 1896.

(The accident, which occurred Feb. 25, was described in our issues of Feb. 27 and March 4, and it was explained that the recent frosts had made it reasonable to assume that the ice in the river would not move before the work was completed. A temporary trestle is now being erected The portion of the truss erected, amounting to about 150 tons, is an entire loss, and the wreckage has been broken up by dynamite charges and cleared away, but it is thought that the turntable and machinery can be used.—Ed.)



THE WRECKED ARM OF THE NEW DRAW SPAN OF THE MISSISSIPPI RIVER BRIDGE, BETWEEN ROCK ISLAND, ILL., AND DAVENPORT, IA.

Falsework Carried Away by the Ice, Feb. 25, 1896.

Cost of Repainting a Large Bridge.

Sir: In connection with the valuable table of quantity and cost of paint required for painting bridge spans, submitted by Mr. C. E. Fowler in the last issue of Engineering News, the following memoranda of cost, etc., may be interesting to your readers. I understand that Mr. Fowler's figures refer to painting in the bridge shops, while the figures below show the cost of repainting structures in use. In every case the cost given includes the expense of cleaning and scraping.

Yours respectfully, N. W. Eayrs,
Supt. of Structure, Terminal R. R. Association.

St. Louis, Mo., Feb. 16, 1896.

Cost of cleaning and painting St. Louis Merchants' Bridge. Double track bridge; three spans; total length, c. to c. end piers, 1,566.5 ft.; one coat carbon paint; bridge very rusty:

Material:	
493¼ gallons boiled oil at 58 cts.	$286.08
552½ " " carbon paint at $1.25	690.62
Making 1,045¾ gallons of paint ready for use at 93 3-10 cts per gallon	976.70
Sundry materials, waste, brushes, &c.	69.96
Total cost of material	$1,046.66
Labor:	
48 days at $2.50	$120.00
91 4-10 days at $2.25	205.65
444 4-10 days at $2.00	888.80
51½ days at $1.00	51.50
Total labor	$1,265.95
Total cost, labor and material	$2,312.61
Cost per lin. ft. of bridge	$1.47 6-10
Gallons of paint per lin. ft. of bridge	0.667

Ferry St. span. St. Louis Merchants' Bridge Approach. 126-ft. span, double track, deck bridge. One coat carbon paint.

Material:	
54 gallons of paint at 85.3 cts.	$46.06
Labor	97.70
Total cost	$143.76
Cost per lin. ft. of bridge	$1.14
Gallons per lin. ft. of bridge	0.43

Angelica St. span. St. Louis Merchants' Bridge Approach. Double track, through plate girder (two girders), 68-ft span.

Material, one coat:	
20 gallons carbon paint at 91½ cts.	$18.30
Labor	22.00
Total cost	$40.30
Gallons of paint per lin. ft.	0.3
Cost per lin. ft. of bridge	$0.59 3-10
Exposed surface on bridge	6,250 sq. ft.
1 gallon covered	312.5 sq. ft.

Creosoted Wood Paving at Galveston, Tex.

Sir: In your issue of Feb. 6, J. B. French, of Richmond, Va., asks for information as to the construction, durability, etc., of wood pavements. The writer laid a sample of creosoted wood pavement for the New Orleans Gas Co. in March, 1871, as a test, in the main entrance to the works. It was constructed as follows: The blocks were cut from 3-in. cypress plank, varying in width from 6 to 12 ins, and cut 6 ins. long. The blocks were saturated with dead oil of coal tar, using about 12 lbs. per cu. ft. The foundation was coal ashes and cinders, on which a bowlder pavement had been laid for a term of years. I excavated to a depth of 4 ins. below the grade and laid a 4-in. tar concrete pavement over the surface; and placed the blocks on this in the usual manner, leaving spaces varying from ¾ in. to 1 in., and filled the spaces with gravel, saturated the gravel with soft pitch, swedged the gravel between the spaces, and rammed the blocks to a solid and even surface, then coated the whole surface with hot coal tar and sanded it. This pavement is in a perfect state of repair to-day, although subjected to all the traffic passing in and out of the works.

The city of Galveston, Tex., had five blocks aggregating 7,500 yds. laid on Market St. in the winter of 1874-75 with creosoted yellow pine, of the same dimensions as above, but laid on the natural material of the island, which is a fine pack sand. Various portions of the pavement have been taken up and relaid for the construction of street railways, water-works and sewers, and owing to the inferior manner in which it was relaid is somewhat out of grade, but not a sign of decay is shown in any of the thousands of blocks on the streets.

During the past two years Galveston has paved several streets, aggregating 130,000 yds. in the following manner: The blocks used were cut 5 and 6 ins. long, from 5-in. yellow pine, varying from 6 to 10 ins. in width. The different lengths of blocks were for streets having light or heavy traffic. The blocks are laid closely together, leaving no spaces other than the inequality of the blocks would make. The spaces are filled with coarse dry sand, and the surface is rammed sufficiently to give the blocks a firm bearing and uniform grade, the concussion settling the sand solidly between the blocks. When this is done the whole surface is flooded with hot coal tar, which saturates the sand and cements the blocks together, making a smooth and even surface, similar to asphalt, and this can be subjected to the heaviest traffic if laid on concrete or other solid foundation.

The cost in Galveston is $2.40 and $2.60 per sq. yd. for 5-in. and 6-in. blocks respectively. Creosoted wood is used in nearly all large European cities, but has not been introduced in this country outside of Galveston, but if introduced, would most assuredly make a desirable pavement owing to its durability, smooth and uniform surface, noiselessness and antiseptic qualities.

Respectfully yours, J. W. Byrnes.

317 Twenty-second St., Galveston, Tex., March 2, 1896.

(The plant built by Mr. Byrnes for creosoting paving blocks at Galveston, Tex., was described and illustrated in our issue of April 12, 1894.—Ed.)

Proper Consistency of Concrete.

Sir: I do not wish to prolong the discussion as to the proper consistency of mortar, but one or two errors in the publication of my letter in your issue of Jan. 9, 1896, make my meaning rather obscure, and Mr. A. S. Cooper, in his letter in Engineering News of Feb. 13, very properly criticizes the references given as irrelevant.

In my letter I stated that the tests referred to were in part published in Engineering News, and I did not give the dates of publication, as the tests published do not relate to the subject under discussion.

The references given (Eng. News, Feb. 7 and Nov. 21, 1891) were supplied by the editor and are foreign to the question. Yours truly,

Alden H. Brown.

Fruithurst, Ala., Feb. 17, 1896.

(We may explain that it is our custom when correspondents, in sending letters for publication, refer to articles already published in this journal, to add the date of publication for the convenience of readers who may desire to look up the reference. We regret that in this case the citation of the reference should have caused a misunderstanding of the letter.

We have received from Mr. A. S. Cooper, who, as our readers will recall, has taken a prominent part in this discussion, a letter sent to him after the publication of his letter in our issue of Feb. 6, with permission for publication. The letter is as follows:—Ed.)

A. S. Cooper, C. E., Savannah, Ga.

Sir: Your article in Engineering News of Feb. 6, on the proper consistency of concrete, is to the point. I have had a large experience in the use and testing of cements, in the manufacture of cement sewer pipe, and entirely agree with you that at least 40% of water should be used in order to secure the best results. Any one who has to do with cement quickly decides for himself, if he does any testing at all, that the old assertion "that it only takes 9 oz. of water to set 33 oz. of cement and all above that proportion only evaporates and leaves a void in the mixture" is fallacious in the extreme.

We make our pipe of one to two mixtures and I have yet to hear of a single well-made cement pipe that has failed under any circumstances. We select our gravel and sand mixture with the same care we do our cements and never think of testing one without the other. In contracting for concrete work about the country, it is absolutely necessary to test the proposed cement with the sand, gravel and other aggregates that are easiest accessible to the work in hand. Here it seems to me is where a great many failures occur. Even to most engineers, sand is sand and gravel is gravel, regardless of its value for use with cement.

Test your cement neat, then find its value with reference to the sand at hand. It does not follow that because certain results can be secured with any standard sand, that that result can be depended on for any sand. What is true of sand is equally true of gravel and broken stone, though perhaps in not so large proportion.

In making sewer pipe we find that a larger proportion than 40% of water is disadvantageous for the reason that under the heavy tamping the excess of water follows the casing of the mold on the outside of the pipe being formed and the core on the inside and takes with it the finest particles of the cement, thus weakening the pipe. Hair cracks then form on the surface and the pipe has a dull sound instead of a ringing one when struck with a hammer.

In my opinion the manufacture and use of cements is very much in its infancy and a great field is before the experimenter. The commercial cements of the same price are practically of equal quality and are easily tested, but to find the best sand that is also the cheapest, to determine the amount of water to be used; the manipulation of the mixture, wet and dry, and its final ramming in place is too often in the hands of men who care nothing for results. The difference between the proper and improper methods is the difference between success and failure.

I trust you will publish more of your experiments.

Yours respectfully, Henry Van Arsdale,
Racine Cement & Pipe Co.

Racine, Wis., Feb. 12, 1896.

Improper Use of the Term "Moment of Resistance."

Sir: The letter of Prof. Johnson in your issue of Feb. 27, regarding the improper naming of the function $\frac{I}{n}$ in the useful handbook published by the Carnegie Steel Co. is of great value. It is certainly a grave error to name this function the 'moment of resistance." Great confusion of thought is likely to result from the use of this name, and it is highly desirable that it be named to conform to the best usage.

Prof. Johnson suggests that it be named the "Moment of Resisting Area." I do not wish to discuss the propriety of this name, which appears to be new. It seems to me that it would be better to adopt a name already in use.

Prof. Reuleaux, in his valuable work "The Constructor," gives the function $\frac{I}{n}$ a name which is called "Section modulus" in the American translation of the book. Perhaps an equally good translation would be "Section factor."

The propriety of this name will be apparent upon a moment's reflection. The elementary equation for the strength of a beam is

$$\text{Bending moment} = \text{Moment of resistance}$$

$$M = S\frac{I}{n}$$

The bending moment M is derived from the weight and the length of the beam, the method of support, and the manner and amount of the loading. The moment of resistance is derived from the allowable fibre stress S and the function $\frac{I}{n}$ which depends upon the dimensions and shape of the cross-section. It is through the function $\frac{I}{n}$ that the shape of the beam enters into the equation of strength, and it seems eminently fitting that this function should be named the "Section modulus" or "Section factor," as has been done by Prof. Reuleaux.

Very truly yours,
Charles H. Swan, M. Am. Soc. C. E.

110 Boylston St., Boston, Feb. 28, 1896.

Sir: A logical and definite nomenclature is a desideratum in every branch of science. It is well known, however, that the conservative instincts of mankind make it by no means easy to displace a faulty term which has once come into general use, even though the advantage of a change may be quite clear.

In your issue of Feb. 27 Prof. J. B. Johnson calls attention to the incorrect use of the term "Moment of Resistance" in our common handbooks.

When used in the theory of bending, this expression has, of course, only one proper meaning—viz., to indicate, in the case of a beam subjected only to transverse loading, the resultant of all the axial forces at any cross-section.

As is well known, this resultant will in every case be a couple or moment. The distribution of the axial forces themselves, at different points in the cross-section, can only be ascertained approximately. In our ordinary theory, we assume that the sections are plane before bending, remain plane after bending, and that the longitudinal layers of the beam expand and contract laterally as if disconnected from each other, and further, that the deflections are slight. Under these not unreasonable assumptions it can readily be proven that

$$R = s_1\frac{I}{d_1} = s_2\frac{I}{d_2} = M$$

where

M = moment of external forces,
R = moment of resistance,
I = moment of inertia of the cross-section,
d_1 = distance from neutral axis to extreme fiber on convex side of beam
d_2 = distance from neutral axis to extreme fiber on concave side of beam,
s_1 = maximum tensile unit stress (at extreme fiber),
s_2 = maximum compressible unit stress (at extreme fiber).

The quantities $\frac{I}{d_1}$ and $\frac{I}{d_2}$ are of course dependent solely on the geometrical shape of the cross-section, and when the latter is symmetrical about the central axis, the two expressions are identical. Professor Johnson proposes to call these qualities "Moments of Resisting Area."

It would appear wiser not to make further use of the somewhat overworked word "moment." Professor Reuleaux, in common with other German writers, has always preferred to use the expression "Querschnitts Modul" or "Modulus of Cross Section." His great work "The Constructor" has recently appeared in America in an English translation.

The present writer has always preferred to use this form, rather than any other, tabulating the "areas" and "moduli" of different rolled shapes, as well as their "moments of inertia" and their "weights per unit of length."

It is perhaps only fair to add that the confusion complained of by Professor Johnson seems to prevail equally in German, English and American engineering literature.

Thus in Humber's "Handy Book of Strains" (p. 62) we find the "Moments of Resistance" of beams correctly given, while other English writers, and among the Germans, Prof. August Ritter and the well-known hand book "Huette" are less constant in their use of the term.

Against the use of the term "Moments of Resisting Area" it may also be urged that the compound word "area-moment" seems to have been employed by some English writers to distinguish the "geometrical" moment of inertia from the same magnitude when used in connection with "mass." (See Cotterill Applied Mechanics, p. 313.)

Very truly yours,
Henry Goldmark, M. Am. Soc. C. E.

Chicago, Feb. 29, 1896.

Sir: Permit me to refer briefly to Prof. Johnson's recent letter concerning a common and incorrect use of the term "moment of resistance." His point is well taken and well maintained, to the effect that the term should be used solely to define the moment about the neutral axis, of the longitudinal forces resisting flexure. I suggest, as an amendment, that it be replaced by the expression "resisting moment." The rythmic analogy with "bending moment" suggests the close relation between the two mathematical quantities. The value of any suggestive aid like this is possibly not apparent to the engineer who has not had forced upon him the difficulty of making the beginner grasp the meaning of these simple matters. I can assure you, however, that it is great.

The definition of $\frac{I}{n}$ as the "moment of resisting area," is to be commended.

Very sincerely yours,
James L. Greenleaf.

135 Broadway, New York city, March 3, 1896.

Sir: I have read the letter of Prof. J. B. Johnson to the Carnegie Steel Co., printed in your issue of Feb. 27. The erroneous use of the term "moment of resistance" in the hand-book of that company, though apparently a small matter and not at all confusing to those who are in the habit of using such hand-books, is nevertheless inexcusable. It makes explanation necessary on the part of an instructor and tends to cause confusion which should never have been called into being. The tenacity with which the word "strain" has hung to a "stress sheet," innocent of any signs of distortion, affords an example of the difficulty of eliminating erroneous terms from a professional vocabulary. There is no excuse for the introduction of others.

The expression "moment of resistance" is also erroneously used in the hand-books of the Passaic Rolling Mill Co., the New Jersey Steel & Iron Co. and Jones & Laughlin.

Palmer C. Ricketts.

Rensselaer Polytechnic Institute, Troy, N. Y., March 3, 1896.

(While we agree with Prof. Ricketts, and with other correspondents, in his condemnation of the improper use of the term "Moment of Resistance" in various hand-books, we can by no means agree with him in his opinion that "strain-sheet" is an erroneous term. On the contrary, we hold that it is a perfectly correct term and good English. The use of the word strain to mean distortion is a comparatively recent, and we think unfortunate, incorporation into the literature of mechanics. Our opinion on this question was given at length in our issues of June 2, 9 and 23, 1892. While we object to the definition of the word "strain," as used in mechanics, in the Century Dictionary, we think its definition of strain-sheet is correct. It is as follows:

In bridge-building, a skeleton drawing of a truss or other part of a bridge, with the calculated or computed greatest strain to which it will be subjected annotated at the side of each member. Also called stress-sheet.

In this definition the word strain is correctly used to signify a force which tends to cause a distortion, not the distortion itself. It is perfectly correct to say a strain of 10,000 lbs. per sq. in., but we think that even a student of the modern text-books in which strain is used as a synonym of stretch, would scarcely think it correct to say a strain of 20% in 8 ins.—Ed.)

Statutory Regulation of Interlocking Signals for Railway Grade Crossings.

Sir: I have been very much interested in your editorial on "Statutory Regulations of Interlocking Signals for Railway Grade Crossings" contained in your issue of Feb. 6, and it may be of interest to look further into the meaning and effect of the several interlocking acts of the State of Illinois. Probably the most important clause in the Act of 1891, of which you have made no mention, is the concluding portion of section 3, which is as follows:

Said Commission shall further designate in such order the proportion of the cost of the construction of such plant and the expense of maintaining and operating the same, which each of the companies or persons concerned shall pay. In case, however, one railroad company shall hereafter seek to cross at grade with its track or tracks the track or tracks of another railroad and the Railroad and Warehouse Commission shall determine that interlocking or other safety appliances shall be put in the railroad company seeking to cross that grade shall be compelled to pay all costs of such appliances, together with the expense of putting them in and the future maintenance thereof.

It will be noted that this section of the act does not provide for the operating expense, and I bring this matter to your notice in case any legislation of this character is proposed in any of the several states so that the framing of the act may be such as to clearly define whether the word "maintenance" as used here is sufficiently broad to cover the word "operation." The adjudication of this section of the act of 1891 has brought out considerable discussion, as in the case of the Tamaroa & Mt. Vernon R. R., petitioner, vs. the Louisville & Nashville R. R. and Southeastern & St. Louis R. R., respondents.

This petition was under the act of 1889, and the Commission having decided that it was necessary to protect the crossing with suitable interlocking and signaling appliances, under the act of 1891, the controverted question was whether or not the petitioning company should pay the entire expense of the operation of the interlocking plant, and the Commission held that since the word "operating" was used in a foregoing section of the same act and was not used in section three, the word "maintainance" could not properly be interpreted to include operation, and ruled that the expense of operation should be apportioned between the companies on such a basis as was deemed equitable under all the circumstances of the case.

Since the cost of operating an ordinary interlocking plant is the most important ultimate expenditure, and since it is a constant fixed charge so long as the interlocking plant is maintained, it appears to me that this point should be clearly set forth in any act of this character, so that there may be no possibility of misconstruction, to the end that the findings of the Commission may not be questioned.

A further careful consideration of the effect of this section of the act of 1891 will, I think, show that there may be considerable injustice done in carrying it out, and it may not be improper for me to say that when this bill was before the legislature of Illinois I made a very full report upon the matter to the Commission with the purpose of showing that in some cases it would be very undesirable to compel a new railway to pay all the costs of installation where it crossed existing railways at grade. I believe the framers of this act had in mind ordinary country crossings, where there were but one or two tracks involved, and it is manifest that in many cases where railways are seeking to secure entrance to large cities, the charges put upon them by this act would be prohibitory and prevent them from constructing an independent line, thus forcing them to be tenants of some one of the existing lines.

I have in mind the crossing of the Chicago, Madison & Northern Ry. at Stewart Ave., Chicago, where the interlocking plant, together with the attendant expenses, required an investment of $100,000. Also a similar case at East St. Louis, where a railway is now seeking entrance, and if this act is carried into effect the charge put upon the new company will very likely reach $50,000.

It appears to me that where a new railway crossing other railways introduces new elements of danger to traffic, it should be compelled to provide the best known methods for avoiding same; but if crossings and complications at the point where the new railway is to cross already existed and the introduction of another pair of rails does not materially increase such danger, there seems to be no justice in compelling the new company to protect the traffic of all the other railways which may be operating over and across each other's tracks at that point, and it is manifest that the mere paralleling of an existing track by the laying of a new track does not materially increase the danger at that point, excepting so far as the added traffic on the new line may be considered an increased element of danger; and, since the new crossing cannot be protected without bringing into the scheme all tracks and switches within a radius of at least 1,000 ft., the excessive charge put upon the new crossing seems unwarranted by the conditions, for if the existing crossings and tracks had been protected before the introduction of a new road, the new crossing could have been introduced without any more expense than that attended by the installation of signals on the new track.

While the Commission conceded the force of this argument, they felt that since the bill was at the third reading in the Senate it would not be advisable to recall it for fear interest would be lost in the matter and they would consequently be unable to secure the enactment of any law. I believe no change has been made in this section of the act up to the present time.

I note that you say: "It is evident at once that in the majority of cases mutual arrangement between the companies interested was sufficient to effect the improvement without the aid of the Commission." My experience is that the interlocking act of Illinois has been very much appreciated by the railways of that state for the reason that it enabled them to make progress in the protection of crossings and junction points without being compelled to bear the entire cost in cases where other companies involved refused to bear their fair proportion; at the same time it appears that the first rulings of the Commission, as ably set forth by the Honorable Isaac N. Phillips in the first cases adjudicated under the new act, has had much to do with the "mutual arrangement."

The decisions in the cases of Paducah Junction, Jackson Junction, Belt Line and Chicago & Alton Crossing and Corwith Crossing, five separate and distinct points in Illinois where the conditions surrounding each seemed to involve all the various questions of first cost, maintenance and operation, very clearly set forth what position the Commission would take; and there seemed to be little use in bringing subsequent cases before the Commission, knowing in advance what the result would be. It seems, therefore, that the great advancement made in protecting crossings in Illinois is to be directly credited to the interlocking acts as carried out by the Railroad Commission of that state.

You properly set forth the danger of giving any Commission the powers that are granted in the several acts of the State of Illinois, and it would appear that such power in the hands of unscrupulous men would be very disastrous to the railways. It is, therefore, highly creditable to the intelligence and honesty of the Commission of that state that no causes for complaint have arisen in this respect.

It might be practicable to limit the powers of the Commission in this regard, and compel it to make full report to the Governor of any crossing which it considered especially necessary to protect. It does not appear to me feasible, or within the proper jurisdiction of the federal authorities, to have the protection of any railways or railway crossing controlled by the federal government, and I am sure that no such act could be passed, as it would conflict with the proper police regulations of each state. I think the question of uniformity of signals, etc., may well be left to the intelligence of signal engineers, and there is no apparent danger of leaving the regulation of such work to the state authorities.

All properly organized railway commissions now employ a consulting engineer, whose duty it is to make annual reports on the physical condition of every railway in the state, and he is, therefore, equipped with the knowledge of the conditions surrounding each of the several crossings in his state and can keep the Commission advised on the subject.

I believe that the good results obtained by the Illinois Commissions have been brought about largely by a desire to encourage the introduction of signaling appliances, and the requirements of the Commission of to-day are found to be more stringent than the first set promulgated by its first Consulting Engineer. It was considered better policy to overlook certain apparent defects in the first plans, believing that they could gradually strengthen their requirements, and the fact that the rules and regulations promulgated by the Commission are now standard on many railways in the United States and have been accepted by the Dominion Government bears out this opinion.

Charles Hansel, M. Am. Soc. C. E.

THE SUPREME COURT COMMISSION'S REPORT ON THE NEW YORK RAPID TRANSIT RY.

The proposed rapid transit railway system for New York city has been approved by the Supreme Court Commission, which has for several months had the enterprise under consideration, and this approval marks an important point in the history of the enterprise.

It is probably not generally realized by engineers that this is the most important engineering work, judging by the amount of money involved, now under way in the United States. The scheme has been so long before the public, however, and has met so many vicissitudes that doubtless many of our readers have failed to keep in mind what is its present status and what the present report means with respect to the future prospects of the work. For the benefit of such readers we may briefly summarize the history of the scheme as follows:

Efforts to secure legislation for a rapid transit railway in New York city began when the Hon. Abram S. Hewitt was Mayor of the city in 1888. Political pulling and hauling, however, prevented the passage of any law until the winter of 1889-90, and the commission which was established by this law did not begin actual work until 1891. The plan which the first law established was for the commission to lay out a route and sell to the highest bidder the franchise for building a road over it upon certain plans. The commission's scheme had to run various gauntlets, all of which it passed successfully; but when the franchise was at last put up at auction no one would bid for it, a result which might well have been foreseen, and which was, we believe, an entirely fortunate outcome for the city.

Following this failure, the public demand for rapid transit led to the enactment of the Rapid Transit law of 1894, the appointment of a commission, and the approval of the project by popular vote in November, 1894. During 1895 the commission and its engineers were engaged in making detailed plans and specifications, and late in that year they submitted these plans to the Supreme Court for approval. (The law provided that in case consents of a majority of property-owners adjacent to the lines was not secured, application should be made to the Supreme Court, which should appoint a commission to pass upon the question and its approval confirmed by the court should have the same effect as the property-owners' consent.)

The Supreme Court appointed as members of a commission to review the plans Messrs. Frederick R. Coudert, Geo. Sherman and Wm. H. Gelshenen, and for three months these gentlemen have been hearing testimony for and against the proposed enterprise. Their report approving the work was published in full in most of the New York daily papers of Sunday, March 8. We have extracted the features in it of chief interest to engineers as follows:

The report made by the Board of Rapid Transit Railroad Commissioners appears to have been the result of very careful and assiduous labor by competent and duly authorized officials assisted by engineers of eminence and experience. The general public and parties especially interested were afforded an opportunity to be heard before that board, and to present such objections as might seem proper, whether affecting special interests or the general welfare of the citizens. The plan of an underground road under the surface of Broadway was finally adopted as the one which offered the greatest advantages to the public and which promised the best results.

The commission then reviews its own work and explains that it had no authority to make any changes in the plans of the Rapid Transit Commission. It had simply to approve or disapprove the work of that body as a whole; and the rule it laid down for its guidance was as follows:

If, then, the construction and operation of this road is likely to result in a public benefit and to promote the general interests of the community by furnishing additional, safe and convenient means of rapid transit, without such disadvantages as would outweigh its benefits, these commissioners conceive it to be their duty under the law to give their sanction to the route proposed, and to declare that the road ought to be constructed and operated.

We have made further extracts from the report as follows:

That rapid transit facilities in addition to those afforded by the elevated roads are needed by the citizens of New York is scarcely open to question. All those of our citizens who are compelled to travel during the morning or afternoon hours on the surface roads or elevated trains need not be informed of the imperative necessity of additional facilities which will enable them to reach their homes and business places respectively with some approach to comfort. It is not unreasonable on the part of the people of New York to expect that at some time in the future they may during any hour of the day travel from any point in the city to another point without incurring the hardships and even indignities to which they must perforce submit.

Underground and Elevated Systems Compared.

The subject has been discussed before us as to the comparative merits of an underground system, and one similar to that in use by the elevated roads. It is not the purpose of this commission to discuss this at any length. They have considered the arguments on both sides, and they can see manifest advantages in additional elevated facilities. It is none the less true, however, that after a careful examination of the case with all the facts before them the Board of Rapid Transit Commissioners, composed of experienced, able and public-spirited citizens acting in the discharge of official functions, have concluded that the only adequate method to satisfy the just expectations of our people was by the underground road. We are inclined to concur with them in this view, although it is idle to deny that prima facie there are objections to such a scheme. Travelers generally do entertain a prejudice against a system which compels them to go down a long flight of stairs, and to hide themselves from the sunshine and the open air for a given length of time. But these inconveniences must be put up with if real rapid transit is to be furnished the people of New York. As to the objections that may be and have been urged to the tunnel or underground system, they are, no doubt, many and serious, but no other system can be devised which is not more or less injurious to some of our citizens. Granting that there were longitudinal streets or avenues, which might be taken for elevated transit, the value of property is now so great, and the rule in awarding damages so liberal to the owner, that the superadded expense from that source would probably be a prohibitory element in the problem. By our underground system we bring into active use a part of the city which has heretofore been of no value except for sewers, gas pipes and other pipes. We provide at the same time a permanent, cleanly, wholesome, method of disposing of these unavoidable nuisances for all time to come.

Opposition to West Broadway Route.

The main attack upon the proposed plan is that Broadway should not be selected for an experiment of this nature. It has been truly said that Broadway is not only the most important street of this city, but probably of any city on this Continent. It is impossible to move a block of pavement on the surface of that thoroughfare without disturbing the interests or the comfort or the convenience of some of our citizens. The experience that they have had in the repaving of Broadway and the building of the cable road must satisfy any ordinary observer that only a great necessity can justify an excavation in that street for public purposes. Your commissioners deem it proper to say that they have not overlooked the arguments presented to them against the use of Broadway, but reflection has convinced them that these temporary inconveniences are unavoidable. They are great, but not out of proportion to the magnitude of the proposed plan. Laying aside the question of damage to the property-owners (to which we shall presently advert), modern efforts of excavation and a due regard for the rights of the traveling public will reduce these inconveniences to a minimum. It is proposed that one-half of the street shall be constantly left undisturbed, and that while the work of tunneling is in progress the part that is subject to the purposes of excavation will be so covered as partly, if not wholly, to prevent serious obstruction to travel. The Rapid Transit Commission have not lightly disposed of this subject. They appear to have duly weighed the objections based on the congested condition of Broadway, as against the advantages which that street offered for rapid transit, and concluded that the arguments in favor of selecting the greatest thoroughfare of the city exceeded the corresponding drawbacks. In this we think they were right. A rapid transit scheme must present attractions to a contractor or he will not touch it. The locality through which the greatest number of persons daily pass will offer, other things being equal, the most alluring field, while affording accommodation to the largest number of persons.

Engineers' Estimates of Cost.

The testimony adduced on the subject of probable cost has been confusing and conflicting to a remarkable degree. The chief engineer of the road, who may be presumed to have given careful attention to the questions involved in its consideration, is satisfied and has sworn that the cost of the road will not reach the estimated sum of $50,000,000. He is sustained in this opinion by other engineers, one of whom, Mr. Sooysmith, expressed himself as ready to prove his faith by his works, and to become interested in a syndicate that would undertake the building of the road for that sum. Concerning the opinion of this engineer, ex-Mayor Hewitt testified: "I can only say that Mr. Sooysmith is one of the highest authorities in the engineering profession, and anything that he said or believed I should be inclined to adopt as my own view." On the other hand, we have gentlemen, eminent, too, in their profession, who have given figures and arguments to establish that the construction of the road would involve an expense of $80,000,000 to $90,000,000. If your commission were bound to pass upon this question of cost, and to decide which class of experts was entitled to the highest degree of confidence, they might feel that they were placed in a position of great embarrassment. They have not the special aptitude to decide what is likely to be the cost of excavation, the expediency of underpinning, and the expense as well as the expediency of sheet piling. These matters belong to a special art, and when the masters of that art are hopelessly at war with each other, men who claim no knowledge on the subject may confess their incompetency. But, in view of your commission, it is not necessary to determine whether the road can be built for $50,000,000 or whether it will cost $90,000,000. It might be their function to grapple with this problem, and to undertake its solution, if the question before them were whether or

not the city of New York should undertake the building of this road. If there were in such a case a reasonable doubt as to the probable expense of the enterprise, it might be proper to decide against a plan the prosecution of which might injuriously affect the city's finances, but it will be remembered that the risk of embarking in the building of the road is not the risk of the city. The road is to be constructed and operated by individuals sui juris, men who will have an opportunity to study the subject from a practical standpoint, and who will probably not venture their funds into an enterprise that fails to present a reasonable prospect of financial profits.

That it is possible to build the proposed road is beyond question. It may not now be disputed that engineering science has reached a point that, notwithstanding all the difficulties which an underground road undoubtedly offers, the skill and ingenuity of men is quite able safely to carry the scheme to a practical end. This we believe to be conceded. There is probably no one of the engineers called by either side who would not be willing to undertake the construction of a road on the design submitted. Your commission, therefore, have come to the conclusion that the only safe and practical way to determine a matter as to which so much conflicting evidence has been furnished is to give their approval to the construction of the road, and leave the Board of Rapid Transit Commissioners to test in the only practical form the possibility of bringing the execution of their plan within the statutory limit of amount. If they can find a contractor of sufficient responsibility and means in a properly guarded contract to undertake the construction of the road, they should have the opportunity to do so. Until this test has been applied the question must remain in doubt. Until then the chief engineer, Mr. Parsons, and those who agree in opinion with him will continue to insist that the road might have been built for a less sum than $50,000,000, while their opponents will, with equal good faith, demonstrate that it would be impossible to construct the roadbed for less than $90,000,000. It would be unfortunate for the cause of rapid transit if so important a question were left unsettled, and should continue to be a thesis for academic discussion, when it can readily be solved in practice. If the Rapid Transit Commission fail to find such a corporation, then Mr. O'Rourke, Mr. McNulty and the other witnesses for the opposing owners will be sustained and the theories confirmed by a crucial experiment. A contrary result will afford equal satisfaction to the chief engineer of the road and to the other gentlemen whose estimates reduced the cost to $50,000,000.

We are of the opinion, then, that the Rapid Transit Commissioners would be allowed to prove the accuracy of their figures and the practicability of their plan. We are convinced that if the road can be built at a reasonable cost it ought to be built. We are equally convinced that we shall never know whether it can be so built until an opportunity is given to competent contractors to say whether they will or will not undertake the construction of the road. Until then experts will differ, and non-experts may guess, with advantage to no one.

Will the Railway be a Profitable Enterprise?

Many witnesses were examined before us to show that the road would or would not be a paying venture, even if it were built. Experts have varied in their estimates here, as they have on the subject of cost, with the difference, perhaps, that when speaking of the matter of probable profit they assumed a prophetic role, and deal wholly with the secrets of the future. Conceding, however, that they have special facilities from their past experience for thus anticipating the developments of the years to come, it is sufficient to say that the Board of Rapid Transit Commissioners have examined the question with care, and have come to the conclusion that the road would probably prove to be very profitable. They have produced testimony to show that this road would be no exception to all others, and that the amount of patronage which it is likely to receive will exceed the expectations even of its friends. We have no reason to doubt that this is a just expectation. Certainly the past history of the surface and elevated roads justifies its adoption. Our invariable experience thus far has been that the facilities for transit never increase so rapidly as to meet the growing necessities of travel. But here again practical men should be left to deal with this question, and if after mature consideration a contractor is willing to wager $1,000,000 that he can build the road for $50,000,000, and to give bonds that he will carry out his undertaking, we do not see why over-anxiety lest he fall into error should prevent us from giving him an opportunity to prove the sincerity of his conviction.

There is also an incidental advantage of no small interest to our people in adopting the Broadway route, and that is the permanent disposition of the underground pipes—sewer-pipes, gas-pipes, water-pipes and electric wires. One of the most attractive features of this scheme is the pipe galleries which are to be constructed in connection with the road. If the plan is carried out on the lines indicated by Mr. Parsons, the chief engineer, a great step will have been taken to relieve the owners of Broadway property and travellers on that street from the annoyance, difficulties and dangers attendant upon the frequent tearing up of its surface street.

Underground Railways not an Experiment.

It must be borne in mind, too, that underground roads have passed from the doubtful stage of experiment; they are in use in London, Glasgow, Baltimore and other cities. Electricity has superseded such polluting agents as coal and oil, thereby disposing of the main objection to underground travel, which has been heretofore inseparable from a foul and unhealthy atmosphere. Immunity from storms, an unincumbered road, the ability to use lands which cost nothing, the incidental improvement of our system of pipes, the suppression of noise, the freedom from danger to travelers on foot or in vehicles, are some of the manifest advantages of an underground system. It has been growing in favor from the very necessity of the case for the last 30 years. As far back as 1866 the Senate of this state appointed a commission composed of the Mayor of New York, three Senators, the City Engineer and the engineer of the Croton Aqueduct Department, to examine into and report on the best system of urban transportation. They in their turn employed competent engineers to examine the railways in London and on the Continent, and after these experts had made a full and elaborate report, and after much time had been devoted to the examination of the various systems suggested to meet the problem, the committee reported that "underground railways passing under streets present the only speedy remedy for the present and prospective wants of the city of New York, in the matter of safe, rapid and cheap transportation of persons and property."

Later, in 1870, the Board of Engineers of New York, with such men as George B. McClellan, William J. McAlpine, Egbert L. Viele and others composing it, investigated the same subject and substantially indorsed the Senate commission on this point. The late General Newton, of whom Mr. Hewitt spoke in such high and deserved terms of eulogy, did also, with other eminent men, give his opinion in writing to the same effect. In addition to this valuable testimony, we see other cities anticipating us in the adoption of that method of transit. We are now in a position where it can hardly be said that we have a choice between sub-surface and elevated roads. Conceding that the latter should have every facility given them to increase their accommodations, it may be taken for granted that in view of the enormous expense incident to a system of construction which involves the taking of valuable private rights, our people would not consent to devote other main arteries of travel to elevated structures. That our citizens will be inconvenienced for a time by the adoption of this plan, if a contractor shall undertake to carry it out, no one disputes, but this consideration, in the opinion of your commission, must be overlooked in comparison with the enduring benefit which would be conferred upon our city were the plan of the Board of Rapid Transit Commissioners carried into effect.

The stimulus that it would give to our city it is almost impossible to conjecture, and therefore, while they have given due consideration to the objections of the Broadway owners, and have not been disposed in any way to minimize them, your commissioners are of opinion and do hereby determine and report that the route proposed by the Board of Rapid Transit Commissioners ought to be adopted, and that the railway determined upon by the said board ought to be constructed and operated.

MR. MANSERGH'S REPORT ON THE WATER SUPPLY OF TORONTO.

The interest of American engineers was aroused a few months ago by the appointment of Mr. Jas. Mansergh, of London, to report on the water supply of Toronto, at a fee of some $15,000. The city has long been agitated over its water supply, there being a strong difference of opinion as to whether the present supply from Lake Ontario, with improvements, should be continued or a new supply from a different source introduced. The contentions have been accentuated by the rising on two occasions of a part of the intake pipe, laid on the bed of the bay, by alleged impurities in the lake water, and, on the other hand, by the advocacy of schemes for new supplies to be furnished by private corporations. Such schemes have often been before the city in the past few years, and have included the promise of water and electric power plants and even navigable canals, if we remember correctly. Various engineers, both from Canada and the United States, have made reports on the subject, and these reports have conflicted in their recommendations. Matters drifted along year after year for some time, but the last rising of the intake pipe made some action imperative. The break of the intake admitted water from the bay, which receives the sewage of the city. This water was declared to be so impure as to be unsafe, and a city of 200,000 inhabitants was forced to depend upon carts going from door to door for its drinking water. The advocates of the various supply schemes seem to have been so suspicious of each other as to make it necessary to go outside of both Canada and the United States for further engineering advice. Mr. Mansergh seems to have been chosen as a man so far removed from the scene of conflict as to be entirely unprejudiced. His fee was sufficient to make it no object for him to bend an ear to any interested parties, or more justly to him, to allay or tend to allay the suspicions of parties filled with mistrust. We say tend to allay, for there was much perturbation in Toronto lest even this eminent English engineer, notwithstanding his handsome fee, should be unduly influenced in some way, or at the least given misleading information. More than this, feelings of local pride were shown by some of the officials when his appointment was under discussion, and it was asked, must we go abroad for engineering talent?

This much in the way of explanation has seemed desirable, since many outside of Toronto have queried why it was necessary to bring an engineer across the Atlantic at such great expense.

Mr. Mansergh's report is dated Jan. 31, and has just reached this country. It advises the continuation of Lake Ontario as a source of supply, thus concurring in the recommendation made in 1893 by Mr. E. H. Keating, City Engineer of Toronto, and the previous report of Messrs. Rudolf Hering and Saml. M. Gray, made in 1889. But Mr. Mansergh advises filtration, which none of the other engineers did in their reports.

The two sources of supply considered as available and adequate are Lake Ontario by pumping and Lake Simcoe by gravity. Before taking up the discussion of the relative merits of these two, Mr. Mansergh disposes of proposed supplies from springs, artesian wells, and from the Ridges Lakes and Rouge Rivers. These he considers as entirely out of the question on account of the small available quantities, except the lakes and rivers plan; which is of doubtful quantity and objectionable quality. It is pointed out that the drainage areas of the latter sources are likely to become too densely populated to serve as a safe catchment area. How these would be regarded in England Mr. Mansergh relates as follows:

> Even in their present condition these sheds would never be selected nowadays at home. Only open mountain pastures, unploughed and unmanured, and with practically no population, are considered good enough as collecting grounds for town supplies.

The relative merits of the two sources of supply, Lake Ontario and Lake Simcoe, are considered under the two heads, quality and cost. First it is stated that Lake Simcoe has a drainage area of 1,100 sq. miles, and Lake Ontario, 270,075; that the average daily discharge of Lake Simcoe by the River Severn is probably 790,000,000 U. S. gallons, and of Lake Ontario by the St. Lawrence, 180,000,000,000 gallons. The drainage area of Lake Simcoe is and probably will continue to be sparsely populated so that there need be no fear of organic pollution. The pollution of Lake Ontario from all other sources is of far less importance, the report states, than that from Toronto itself. Considering broadly the relative sizes of drainage areas and all other factors the two lakes are thought to be very similar from a chemical standpoint, under normal conditions of wind and weather. But on examining a series of chemical analysis of samples from each lake Dr. Edward Frankland, a noted English water analyst, pronounces the water of Lake Simcoe as chemically "very decidedly inferior to that of Ontario." Bacterial analysis of the waters under normal conditions show about the same results for each lake, but samples collected from Ontario during a heavy storm on Jan. 19, 1894, showed 7,880 bacteria per cu. cm., as against an average of 164 for previous examinations. Occasionally, and for short periods, Mr. Mansergh concludes, the bacteriological condition of the Lake Ontario water would make its use unadvisable in its raw state, since among so many bacteria there might be a

few harmful ones. Dr. Frankland, after considering all the governing conditions, says:

As regards filtration, I should strongly advise this to be adopted, whichever source is selected. If the water is not filtered I should, on the whole, prefer Lake Simcoe; if it is decided to filter, then I should prefer Ontario.

Mr. Mansergh, however, considers that the Lake Simcoe water does not require filtration, and omits this from his estimates here, but includes it for Lake Ontario. In place of filtration for Lake Simcoe he would prefer a 100,000,000-gallon reservoir, which would enable a short cessation of draft on Lake Simcoe when the water was turbid.

Having arrived at the above conclusions cost is next taken up, and as the first step in this inquiry the probable growth of population is considered. This is finally fixed at 2% per annum for 50 years, which gives an increase of from 175,000 in 1895 to about 500,000 in 1945.

The water consumption of the city in recent years has averaged 21,665,000 U. S. gallons a day, or about 130 gallons per capita. Such a large consumption puzzles Mr. Mansergh. He says it is three times the estimated allowance made by the Royal Commission on the supply for Greater London, and that he cannot positively account for the difference, but he says: "I have a shrewd suspicion that by far the greater part of the excess is due to misuse or waste in one way or another." As the per capita water consumption in Toronto has been falling for the past few years Mr. Mansergh assumes that it will be still further reduced to 100 Imp., or 120 U. S. gallons, and makes this as the basis of his estimates. The total daily consumption to be provided is therefore 60,000,000 U. S. gallons, sufficient for 50 years to come.

The point of intake at Lake Simcoe is assumed about 1¼ miles east of the east end of Snake Island, and 3,960 ft. from the south shore of the lake. The intake would be a 6-ft. steel pipe ending in a gate house, the pipe invert here having an elevation of about 700 ft. above sea level. From the gate house to the service reservice the aqueduct would be mostly in tunnel, with two pipe siphons and two sections in "cut and cover." The tunnel would be lined with brick and concrete to form a conduit with "curved invert, curved and battered side walls and a segmental arch" 8¼ ft. high and 7 ft. wide at the spring line. It would have a length of about 33 miles, a grade of 1 in 4,000, giving a flow of 5,660 cu. ft. per min., or nearly 61,200,000 U. S. gallons per day. The invert level of the lower end of the tunnel would be 655.4 ft.

At the lower end of the tunnel the ground falls away and afterwards varies so as to give rise to the adoption of the arrangements indicated in the table, the portions designated as "cut and cover" apparently being aqueducts of material and section as described above. Only two of the four pipes constituting the siphon sections need be constructed at the outset.

In estimating the cost of this scheme no allowance was made for right of way, land at the lake and for the reservoir site, for the right to deposit material excavated from the tunnel, nor for the water damages for diverting water from the lake. The estimate, without these items, aggregates $12,000,000, and is as follows:

3,960 ft. 6-ft. steel intake	$198,000	
Valve chamber, etc., and keeper's house	17,500	$215,500
176,001 ft. tunnel	7,110,395	
Shafts	182,760	7,293,155
2,400 ft. cut and cover		86,750
Four 32-in. pipe siphons, each 15,000 ft.	650,000	
River crossings	25,000	
Inlet and outlet chambers	5,000	680,000
9,000 ft. cut and cover		292,080
Four 32-in. pipe siphons, each 23,800 ft.	988,000	
River crossings	25,000	
Inlet chambers	2,500	
Outlet to reservoir	5,000	1,020,500
100,000,000-gallon high service reservoir		500,000
Six houses		12,000
Supply mains		335,000
		$10,434,985
Contingencies, engineering and supervision, 15%, say		1,565,015
		$12,000,000

Mr. Mansergh's estimates for the Lake Ontario scheme are not presented so fully and clearly as for Lake Simcoe, possibly because he is adopting to some extent plans previously devised by Mr. Keating. These plans, as laid down in a special report made in October, 1893, provided for a new intake conduit, partly tunnel and partly pipe, extending between the present intake cut and pumping station, and for a new force main and some new distributing mains. The estimated cost of the new intake was $525,000, and of the mains, $185,000, making a total of $710,000. Mr. Mansergh includes filters with a low lift pumping plant, and, perhaps because looking further into the future, contemplates extensive additions to the main pumping plants, force and distributing mains. Mr. Mansergh's first item, in the estimate given below, seems to cover the new intake as planned by Mr. Keating, but omits the settling chamber, which Mr. Mansergh gives separately. Mr. Keating's figures included 5,500 ft. of 6½-ft. brick-lined tunnel from the pumping station to Hanlan's Point, on the island forming the Toronto harbor, at an estimated cost of $250,000; 7,000 ft. of 6-ft. steel conduit from the end of the tunnel across the island and beyond into Lake Ontario, including a new intake cut, valve house and settling chamber, the latter to be on the island, at an estimated cost of $158,000; connections with and replacements of the old intake, with various accessories, aggregating $117,000, made up the balance of the $525,000.

Mr. Mansergh's estimates may now be given, summarizing the cost of seven 20 to 36-in. mains for which no lengths are given, as follows:

E. Keating's scheme, tunnel under bay and pipe across island	$486,000
Subsiding reservoir	110,000
Filter beds	2,055,000
Pumping plant and filters	110,000
Tramway across island	15,000
New pumping station and high duty pumping engines	450,000
New mains (aggregate)	1,467,750
Total	*$4,963,750
Contingencies, engineering and superintendence, 15%	704,062
Grand total	$5,397,812

*This is some $250,000 less than the total given in the report, owing to errors in addition there.

In order to compare the fixed charges of the two schemes, interest is assumed at 3½ and sinking fund at 1½% per annum. The probable expenditures for construction year by year are forecast, allowance being made for the fact that as planned the gravitation scheme would be carried out almost in its entirety at once, while the pumping scheme could be executed piecemeal as consumption demanded. This latter assumption is greatly to the advantage of Lake Ontario in point of capital account and fixed charges, for not only is the total cost of the Ontario plan less than half that of the Simcoe, but in addition the expenditure is distributed throughout the 50 years under consideration. But this is partly offset by the fact that the operating expenses of the gravity scheme are very small, being estimated at $5,500 a year throughout most of the period, while the pumping scheme involves heavy and increasing charges throughout the period. These charges are worked out in great detail by years and presented in tabular form. The operating expenses for the gravity plan are also presented by years. In short, Mr. Mansergh presents for each scheme the actual outlay year by year for construction, interest, sinking fund and operation. The figures for annual charges are finally brought together by years, as in one comparative table, and are also presented graphically by a diagram. From the beginning of construction in 1896 until 1948, or in 52 years, the total estimated annual charges for the Lake Simcoe gravity scheme aggregate $23,967,447, and the Lake Ontario pumping plan, $15,383,406, a difference of $8,585,041. The total water consumption for the period is placed at 726,173,000,000 gallons, or an average of about 3.3 cts. per 1,000 U. S. gallons for the gravity and 2.6 cts. for the pumping supply. After presenting these totals and averages Mr. Mansergh makes his recommendations as follows:

I think there is no necessity to labor the matter further. I have no difficulty myself in advising you which scheme to adopt. My natural inclination and predilection would be in favor of the Simcoe scheme; but under the special circumstances of the case I recommend you to adhere to your present source.

As I have already said, the considerations that impress me very strongly are the following:

(1) No one can predict with any certainty what the future of Toronto is going to be; it may never grow beyond 200,000 inhabitants.

(2) The Simcoe scheme should not be designed and carried out on less broad lines than I have set out; it would never do to construct a tunnel over 30 miles long with a smaller carrying capacity than 50,000,000 (Imp.) gallons a-day, for it would be such a terrible business to have to make another alongside in a few years' time if the city were to increase faster than has been estimated.

(3) But to do this work involves a very heavy expenditure all at once, which would saddle the Toronto of today with a burden it ought not lightly be called upon to bear.

(4) On the other hand, the pumping scheme can be proceeded with tentatively, and extensions be made just as and when they are needed.

(5) Further, if the gravitation scheme is executed, and 50,000,000 (Imp.) gallons a day be brought to the city, there will be no inducement to diminish the extravagant waste which must now be going on.

(6) But if you continue to pump I am satisfied that by adopting the proper methods the quantity of water to be supplied may be reduced 40 to 50%, with a corresponding reduction in pumping expense, and a long postponement of the spending of capital on new stations and machinery.

(7) The gravitation scheme will certainly involve the construction at the outset of the 100,000,000 (Imp.) gallons reservoir at Eglinton, because it is the only way of avoiding using "riley" water, but it will not be necessary to make the 12 acres of filters in connection with the pumping immediately, but will suffice to build the subsiding reservoir, and perhaps one-third of the filters.

(8) You may banish from your minds any idea that the Simcoe scheme should be carried out because of the power that the water will bring with it. This is a will-o'-the-wisp and a delusion. Power can be manufactured in Toronto more cheaply in other ways.

In discussing one of the schemes for buying water from a company Mr. Mansergh expresses himself as follows:

I advise distinctly that the supply of water to any city should never be entrusted to a company, however serious and stable—it is essentially a municipal business—and wherever a competent, incorruptible and truly representative municipal authority exists, that body should administer and control the water supply in the sole interest of the ratepayers, and without increasing its cost by providing dividends to shareholders.

After having made the above recommendations for continuing the use of the Lake Ontario supply Mr. Mansergh discusses the proposition to develop power in connection with the Lake Simcoe gravity scheme. Taking his own ideas of how gravity works should be constructed as a basis, he estimates the cost of one electrical horse power at Toronto, developed from the Lake Simcoe works, at $152 per annum, which of course would be entirely out of the question. To gain any power under Mr. Mansergh's plan he would increase the size of his conduits from the end of the tunnel to the reservoir from four 32 to two 69-in. steel pipes, thus gaining 96.7 ft. available head. This would give 1,010 HP., gross. This change in plan would increase the cost about $1,700,000, interest on which at 5% would be $85,000.

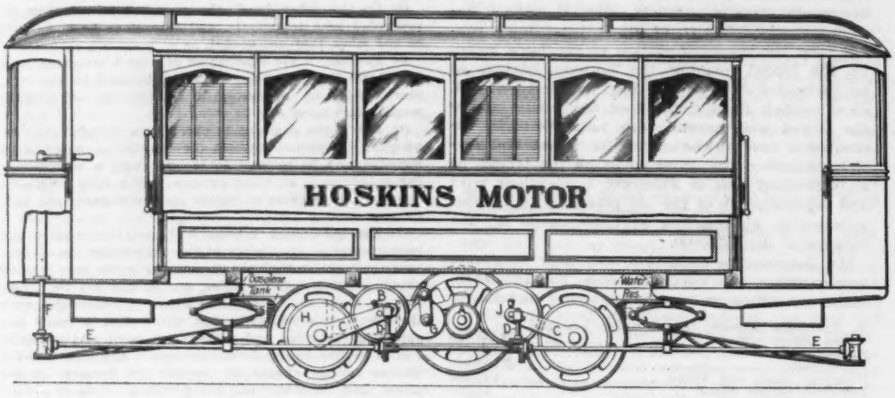
In converting the water power into electric power at 5,000 volts, and transforming this to 500 volts or less for transmission, it is assumed that the 1,010 HP., gross, would diminish to at least 600 net, and that the cost of the plant would be $130,000. The interest on this sum at 5% would be $6,500 a year, making a total annual interest charge of $91,500, which for 600 HP. would be $153 per annum.

As stated at the outset, the employment of Mr. Mansergh was largely due to, or hastened by a break in the water intake which admitted sewage-polluted water from the bay. The bay really serves as a huge cesspool for the city. If a tunnel is substituted for the intake now laid on the bed of the bay danger of pollution from this source will be avoided. But there remains the question, can the sewage reach the intake crib beyond the island? Mr. Mansergh apparently thinks not, and besides he has provided

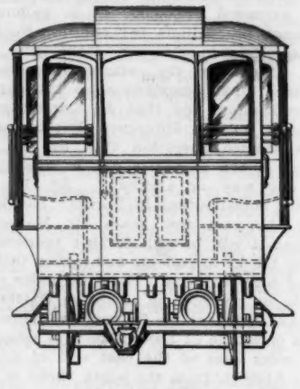
for twelve acres (eventually) of filter beds. Notwithstanding this he finds the pollution of the bay so serious without regard to the present water supply, but at the same time so much connected with it in the popular mind, that he feels called upon to say a few words on sewage disposal. He strongly recommends that the sewage be excluded from the bay, summing up the case as follows:

But I know there is no necessity whatever to argue the question, and that it is merely the cost which stands in the way of a remedy being found. On this I would say that: If you determine to indulge in the luxury of Simcoe water, I fear the diversion of sewage from the harbor will be relegated to the dim future.

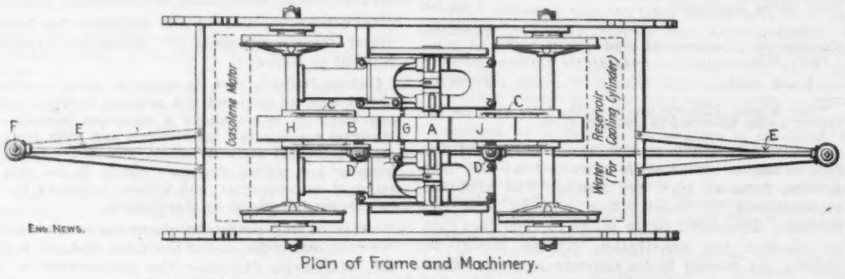
If you adhere to Ontario, several good things will follow, viz.: (1) You will be better able to undertake the sewage work; (2) you will see the desirability of stopping the waste of water, in order to save money to spend upon that work, and to reduce the cost of its execution by diminishing the volume of sewage; and, (3) you will



Sectional Side Elevation.



End Elevation.



Plan of Frame and Machinery.

THE HOSKINS GASOLINE MOTOR CAR FOR STREET RAILWAYS.
The Hoskins Motor Co., Springfield, O., Builders

than would be the case with a single engine of the same dimensions. The cranks are in the same plane.

At the center of the crank shaft there is a friction pulley A, 12 ins. in diameter and 8-in. face. A loose friction pulley B, with an 8-in. face, is hung on the frame C, which in turn swings on the axle of the driving wheel H. The frame C is actuated by the screw D by means of the gears and shafts E and F, the latter shaft being controlled by the motorman. The pulley B bears against a fixed pulley on the driving wheel H. Between pulleys B and A is a swinging pulley G. Now if shaft E is revolved so that the screw D pulls down the pulley B, connection is established between the pulley A and the pulley H by means of the intermediate pulleys G and B and the car moves ahead. As the shaft E is revolved so as to pull down the pulley B it also acts to push up the pulley J by which the car is run backward; thus the revolution of the shaft F in one direction drives the car ahead and its revolution in another direction drives it backward. Of course it will be understood that the crank shaft and pulley A revolve continuously when the car is in operation, simply running idle when power is not being used to drive the car.

The gasoline is carried in a steel cylinder, tested by a pressure of 2,000 lbs. per sq. in., from which it is admitted to the engine cylinders, vaporized and exploded by an electric spark, from a four-cell battery located under the car seats. It is stated by the manufacturers that this battery will operate without charging for four months. The exhaust from the engines is conveyed through two pipes which run the full length of the car next to the seats, and serve to heat it in winter. In summer these pipes are deflected underneath the car. With the exception of these pipes and the battery, all the motive power machinery is attached to the truck frame, thus preventing strains and vibrations in the car body.

To start the engines to operating, a crank is operated by the end driving shaft so as to cause the necessary explosions. The cooling water is piped from the water tank, no pump being used.

No exact figures regarding the cost of operating this motor in actual service are available, nor is other service experience to be had. The manufacturers state that less than 2 lbs. of gasoline per hour will be consumed, developing from 20 HP. to 24 HP. When the car is stopped, only enough gasoline is consumed to keep the engine in motion.

We are indebted to the Hoskins Motor Co., Springfield, O., for the matter from which this description has been prepared. Mr. T. D. Hoskins, the inventor, has received from the County Commissioners permission to build a railway along the National turnpike road from Springfield to Columbus, and this line is to be operated by the gasoline motor. The centre of the track is to be 15 ft. from the centre of the roadway, except through villages, where the track will be laid along the centre of the road.

desire to remove entirely the last trace of uneasiness with regard to the intake.

In the report of Messrs. Hering and Gray, mentioned above, it was recommended that the sewage be diverted from the bay and discharged at Victoria Park, about 6½ miles from the present water intake. This point of outlet was suggested, Messrs. Hering and Gray state, in the report of the city engineer of Toronto for 1886. The city engineer at that time was Mr. C. Sproatt.

THE HOSKINS GASOLINE MOTOR FOR STREET CARS.

The advantages of having independent motors not subject to interruption by derangement of central power station, cable, or feed wires has always made the possibilities of gasoline motors for street cars a problem of interest to street railway managers. In the accompanying cuts we illustrate the general details of one of the most recent gasoline street car motors to bid for public favor. This motor is manufactured by the Hoskins Motor Co., of Springfield, O., and is now being tested on the Wayne Ave. & Fifth St. railway, of Dayton, O.

As will be seen, the motor is carried underneath the car and, together with the mechanism for transmitting the power, is closed in so as to be hid entirely from view. Two engines are used, both coupled to a transverse shaft, carrying at each outer end a 40-in. diameter fly wheel. These serve to give a steady motion and to overcome the inertia of starting. It is claimed that by this use of two engines more than twice the power is developed

THE ERECTION OF HIGH BUILDINGS in the residential portion of Boston is objected to by property owners and real estate men. A bill has been prepared against them, "in the interest of the better health and architectural welfare of Boston," and is now before the Committee on Metropolitan Affairs of the Legislature. Prof. W. T. Sedgwick, of the Institute of Technology, contended that these high buildings tended to overcrowd certain parts of the city and made them less attractive, and the lack of sunlight resulting tended to encourage the spread of disease. Other speakers claimed that the areas likely to be used for business purposes should be carefully excluded from the provisions of such a bill, as a limit of 80 ft. in height would result in a practical confiscation of one-third of the value of the real estate. It was suggested that a commission be appointed to report to the next Legislature.

AN EXPLOSION OF A GASOLINE TANK in the works of the Racine Hardware Co., Racine, Wis., on March 3, caused the fatal injury of five men and a loss estimated at $100,000.

A RE-ENFORCED STEAM PIPE, invented by a Scotch engineer, consists of a copper pipe wound with a close coil of steel wire, the whole being soldered together by immersing it into a melted fusible alloy, the melting temperature of which is above the temperature of the steam to be conveyed. We should judge that the hot alloy would anneal and thereby weaken both the copper and the steel, and that the alloy itself would contribute very little to the strength of the combination.

OIL FUEL FOR LOCOMOTIVES is being used by the Maricopa & Phoenix R. R., of Arizona, and it is said that the three engines, which form its motive power equipment, have been changed from coal burners to oil burners. The line is 45 miles long.

A MODEL RAILWAY BRIDGE of 100 ft. span, built to one-fourth scale throughout, is a recent addition to the equipment of the Purdue University laboratories. The model is 3 ft. 7½ ins. c. to c. of trusses and 6 ft. in height. There are five panels in the truss. The model was designed by Mr. C. B. Peterson, a member of the Faculty, and was built entirely in the University shops.

A COLD STORAGE HOUSE of novel construction, built in northern Michigan, is described in the January number of "Ice and Refrigeration." Its walls are built of cedar blocks laid up with lime mortar like masonry, save that the mortar is laid under each end of the headers 18 ins. long, of which the wall is chiefly composed, leaving a 6-in. air space in each joint. The outside of this wall was given a coat of cement, and the inside was given a heavy coat of quicklime plaster against which dressed sheathing was nailed while the mortar was still soft. The floor is paved with cedar blocks, and the loft over the storage room is filled with straw. The windows have fine sashes with successive 4-in. air spaces. The cost of such a storage building, with cold room 24 × 30 ft. and 8 ft. in height, is given as $600 to $1,000. The building is cooled by natural ice, stored during the winter, and ripe fruits are kept in it a month without injury.